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# THE ANTARCTIC VOYAGES OF R.R.S. *DISCOVERY II* AND R.R.S. *WILLIAM SCORESBY*, 1935–37

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*Evening Meeting of the Society, 9 January 1939*

THE last time the Society heard an account of the work of the *Discovery* Committee was in May 1936, when Dr. Mackintosh described the third commission of the *Discovery II*, concluded in May 1935. The present paper is an account of the fourth commission, which lasted from October 1935 to May 1937, and of two voyages made by the *William Scoresby* during the same period (Fig. 3).

Both vessels sailed with the prospect of doing very useful work. The research of the previous few years had drawn attention to many specific problems bearing on the relations of whales to plankton and hydrology, and, in addition, continued experiments had led to a very satisfactory method of whale-marking. The *Discovery II* sailed on 3 October 1935 to circumnavigate the Antarctic continent during the summer, and the *William Scoresby* left some three weeks later to mark whales south of the Indian Ocean. Also, to supplement the *Scoresby's* marking, a member of the scientific staff was sent to South Georgia to mark whales from a hired whale-catcher.

A short description of the water circulation in the Southern Ocean will make an account of the work at sea more complete.

Over the greater part of this ocean the prevailing wind blows from the west and the currents have a strong easterly trend; they do not flow due east because other factors deflect them north and south, and in the Antarctic region there are movements east and north in the surface and bottom layers, and a current of warmer water east and south in the intervening deep layer. The surface current has a depth of 100–250 metres, and it is cold and of low salt content; as it flows away to the north the loss is made good by fresh water from melting ice and snow, and rain, and by highly saline water from the underlying deep layer. The northward movement is due partly to the combined effect of the west wind and the earth's rotation, and partly to con-

vection. Being much heavier than the warmer surface waters farther north, the Antarctic water tends to sink; in the Antarctic region it is confined in a shallow layer by the highly saline water of the deep current, but farther north, in the latitude where the deep current climbs relatively steeply over a wedge of cold bottom water (see Fig. 1), it soon finds a lower level. North of this latitude, though there is still a northward movement at the surface, there is room above the sinking Antarctic water for a southward movement in the sub-surface stratum, and this current, mixing with the descending Antarctic current, gives rise to a warmer type of surface water known as sub-Antarctic water. At the surface the Antarctic and sub-Antarctic currents generally

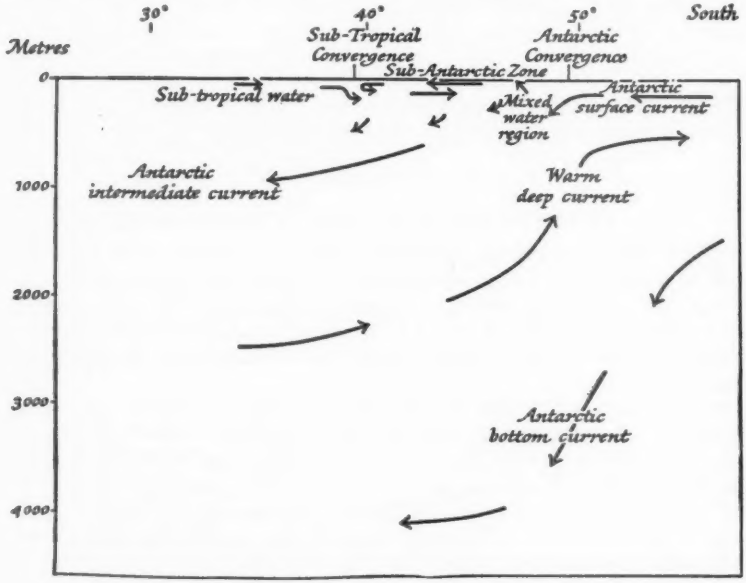



*Fig. 1. The vertical circulation of water in the South Atlantic Ocean*

meet along a sharp boundary which has been called the Antarctic convergence; its position is determined by the latitude in which the deep water makes its steep climb over the bottom water, and since these two currents are subject to only minor variations, it is practically fixed.

Farther north there is another boundary, known as the subtropical convergence, between sub-Antarctic and subtropical currents; both types of current are subject to considerable variations, and in certain localities the position of the convergence may vary by as much as 300 miles. The position shown on the chart (Fig. 2) is as near as possible an average.

Near the Antarctic continent there is a narrow zone in which the prevailing wind is easterly and the surface water flows westwards, and in the Atlantic sector the westward movement extends into the deep layer. When the current reaches the east coast of Graham Land it is turned northwards as far as the

region of west winds, and it then flows eastwards across the Atlantic, bringing what can be described as high Antarctic conditions into relatively low latitudes.

From an oceanographical point of view the Weddell Sea is the most interesting part of the Southern Ocean. One reason is its importance as the source of the Antarctic bottom current. In the south-west corner of the sea, where the freezing is very intense in winter and the deep current is impoverished by

*Fig. 2. The Arctic and subtropical convergences*

mixing, the salinity of the surface layer is raised in winter till it is nearly as great as that of the deep layer, and the two waters mix and sink to the bottom. The increase in salinity is due to the salt which is left behind in the water when sea-ice is formed, and to the freezing of the sources of fresh water while the additions of highly saline water from the deep layer continue. From the Weddell Sea the bottom current spreads eastwards round the whole of the Southern Ocean and northwards into the Atlantic, Indian, and Pacific Oceans. As it goes, it mixes with more of the overlying deep water, particularly near the Antarctic continental slope where the deep water is most

cooled by shelf water; but the bottom temperatures and salinities in the great depths show a continuous increase towards the east and the oxygen content a continuous decrease. These facts show that there is no other region—not even the Ross Sea—where the cold shelf water sinks to the ocean bed. There is a great difference between the bottom waters in the deep soundings east and west of Graham Land: to the east the bottom water is newly formed with low temperature and salinity and high oxygen content, and to the west the temperature and salinity are much higher and the oxygen content less, because the current has travelled round the whole continent.

When *Discovery II* is in the subtropical and sub-Antarctic regions we work one station every day, measuring temperatures and taking water samples at a series of depths between the surface and the bottom, and fishing nets to a depth of at least 1000 metres. In the Antarctic zone extra nets are fished to obtain a more complete picture of the distribution of the small prawn-like krill (*Euphausia superba*), on which the whales feed, and a constant look-out is kept for whales. Near the ice-edge, and in regions where the krill is known to breed, the biological work is still more intensive. We do as much of the work as possible during the dark hours, when navigation is difficult.

Leaving Cape Town on 9 November 1935 we passed north of the Crozet Islands, and then southwards in 60° E. We found heavy pack-ice in 58° 29′ S., and turned eastwards towards Australia. A great search was made for krill, and nets were fished at all depths down to 2400 metres. Mr. J. W. S. Marr overcame the difficulty of fishing nets beneath the ice-floes by shooting the gear with the vessel turning slowly to port; a broad lane or pool opened up behind the ship, and the floes did not close so readily astern as when we steered a straight course. To avoid catching ice fragments, all the nets were closed just before they were hauled out of the water.

Towards the east the ice-edge advanced northwards, and where the surface currents bend northwards above the submarine ridge which joins Kerguelen, Heard Island, and Gaussberg, it reached 56° 30′ S. In the deep water east of the ridge it receded, and in 98° E. open water extended as far as 59° 47′ S.

This point, reached on December 4, proved to be the end of our ice-edge voyage. Captain Hill came in half-way through breakfast with a telegram from the *Discovery* Committee telling him to make for Melbourne while they considered means of cooperating in the search for Mr. Lincoln Ellsworth. Captain Hill was not sure at first that we had enough fuel without calling at Fremantle, but he went into the question with the chief engineer, and as soon as Dr. Ommanney, who was working a station, had managed to get the gear inboard again, we set off direct.

In spite of his careful preparations, Ellsworth's flight was ambitious, and when his wireless messages ceased after eight hours' flying from the Weddell Sea towards the Ross Sea, there were grave fears for his safety. Sir Hubert Wilkins came northwards with Ellsworth's ship, the *Wyatt Earp*, to get another aeroplane from the United States, and the world's press rang with the news of a search for the missing fliers. It was then that the Australian Government approached the Governments of Great Britain and New Zealand with a view to assisting in the search, and the action taken was so swift that

we were sailing from Melbourne with two aeroplanes, seven airmen, and three months' stores less than three weeks after we had received the first telegram at the ice-edge in 98° E.

We sailed on December 23, and went out into an easterly gale which lasted till December 28. The ship was very heavily laden and had a huge deck cargo, but the rapid stowage proved most efficient, and no damage was done. This is

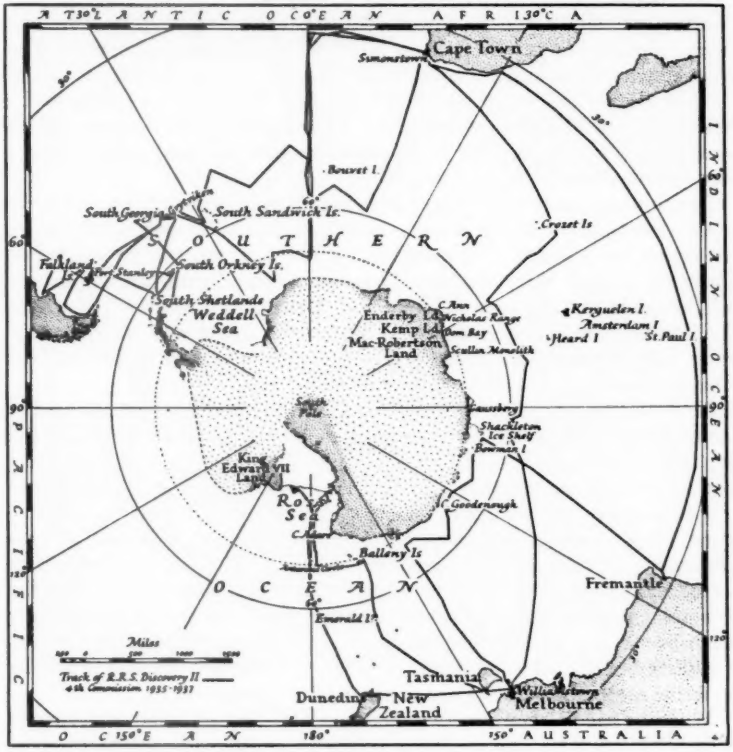



*Fig. 3. Track of R.R.S. "Discovery II," 1935–37*

a tribute to Mr. Walker, our first officer. So bad was the weather that a Melbourne tug parted from her tow and disappeared within 100 miles of us.

After calling at Dunedin to fill up with oil fuel, we steamed southwards at about 10 knots till we met pack-ice in 66° 48′ S., 178° 51′ W., on January 6. Good progress was made until January 10, when we reached 71° 37′ S., 177° 42′ W., and here the floes were enormous; they sometimes stood 10 feet out of the water, and were, as Captain Scott described, "as large as football fields." Our resultant movement during the next twenty-four hours was a drift of 2 miles to the north, but we had made 4 miles through the ice, and were in striking distance of a lead large enough to allow the two Australian

officers, Flight-Lieutenant Douglas and Flying-Officer Murdoch, to take off in the Moth aeroplane to look for further leads. With their help better progress was made, and after a second flight on January 13 we reached open water in 73° 23′ S., 179° 15′ W. early on January 14. The total width of the ice-belt was nearly 400 miles, and Captain Hill brought the ship through without damage in seven and a half days.

The scientists had secretly enjoyed it; liberated from microscopes and burettes, we could spend the day on deck, and waiting on the poop with long poles we pushed on any ice-floe that threatened the rudder or propeller. The Australians and our seamen were doing the same; we had the official title of "poling party," and one of the officers signalled our success or failure to the bridge. We sometimes must have exerted a horizontal push of nearly a third of a ton; it was not much, but it was surprising how we could push the ship's stern round when there was no wind.

At noon on January 15 we sighted the Ross Barrier, and at half-past nine at night we entered the Bay of Whales. Soon we were able to make out a tent on the top of the ice-cliffs at the east side of the bay, and shortly afterwards Ellsworth's signals flying beside it. To make sure that the two fliers, Ellsworth and his pilot, Hollick-Kenyon, were safe, Douglas and Murdoch flew over Admiral Byrd's old base camp at Little America, some 5 or 6 miles away. Soon after, Hollick-Kenyon came off, very fit and well, and we learned that Ellsworth was well except for an injured foot.

Next day, while a party went ashore to fetch Ellsworth, we lay off the fast ice working a station. At no other point round the Antarctic continent did we find such a large deposit of soft mud on the bottom, and our usual bottom net came up completely choked. As it was so heavy we lowered it into a boat, and sat there sorting it. Fish fry in enormous numbers were swimming round the ship's rudder, and there were swarms of a small shrimp (*Euphausia crystallorophias*) something like krill; minke and killer whales were cruising quietly in all parts of the bay. It was Murray, biologist in the *Nimrod*, and Shackleton who first used the name Bay of Whales; Murray described it as a scene of abounding life, and he saw hundreds of whales, including finners and humpbacks. It is not yet clear why the bay should be so fertile compared with the rest of the barrier margin.

When we had finished our afternoon's work the ship had mud from stem to stern, although there was no land in sight. We could not decide whether the hills and valleys that we saw to the southward were ice-covered land; the whole scene was so strange that we felt unable to judge either height or distance. The ice-cliffs on either side of the bay, about 80 feet high, are afloat, but the bay, which is only a remarkable indentation in the ice-barrier, has persisted for a very long time, and there is little doubt that it is formed, as Amundsen suggested, because the barrier stream is partly arrested by some solid land. Byrd has in fact discovered an ice-covered island extending from about 16 to 100 miles to the southward; above this island, which he has called Roosevelt Island, the ice-cap rises to 1200 feet.

There seems to have been little change in the shape of the bay since 1908, and Byrd's most extensive system of huts has suffered little damage, though some of them were erected in 1929. Between 1902 and 1908 a large section of

*"Discovery II" in heavy ice in the Ross Sea*

*Sorting the contents of a dredge*

*The zoological laboratory*

*Young Island, the most northern of the Balleny Islands*

*The north side of Bertha Island and William Scoresby Bay*

*The strait between Bertha Island and the mainland*

barrier had broken out, and that was why Shackleton did not make his base there. Sir James Clark Ross, who discovered the barrier, found an indentation in the same neighbourhood, but 10 miles farther north and 30 miles to the eastward, in 1842. The longitude of the bay is 164° W., and at some time during the summer a ship can reach at least 78° 25′ S.

Soon after Mr. Ellsworth had been welcomed on board we left the bay to work in the region north of the barrier, returning on January 20 in company with his vessel, the *Wyatt Earp*. On the same day we scientists and our photographer Saunders went with the Australians to look at Byrd's camp. We saw inside only one hut, the one in which Ellsworth and Kenyon had lived, but this, and the number of stove pipes standing out of the snow, showed us what extensive preparations the Americans had made for their two successful expeditions. It was very chilly in the hut, and we were glad to get out into the sunlight. Remembering the poor service given by the windmill installed in the *Discovery* at Hut Point, it is worth noting that the three-bladed propeller at Little America was still running smoothly though the camp had been abandoned for nearly a year. Though the gales here are less frequent and perhaps less violent, it must be a very robust machine.

Ellsworth decided to return with us to Australia while his own men salvaged his aeroplane, abandoned some 12 miles away; and after giving a farewell dinner to those in the *Wyatt Earp* we sailed early on January 22.

Continuing our work in the region north of the barrier we arrived off Cape Crozier on the night of January 25, and after working a station we landed shortly after midnight at the foot of the Adélie penguin rookery. Before we reached the shore we saw the record post set up by Captain Scott on 22 January 1902. We found it firm and erect, with no sign of decay; a short length of wire coiled round the upper part must have held the message that directed the relief ship *Morning* to McMurdo Sound. The sky was overcast; we did not see the summit of Mount Erebus, but caught a brief glimpse of Mount Terror.

Our work on the observations made in the Ross Sea will not be finished for a long time, but we have found a few interesting things. Because there is a shallow submarine ridge between Cape Adare and King Edward VII Land, the warm deep current cannot enter the southern part of the Ross Sea, and a first examination of our data shows that the animal community of the southern part of the sea lacks several species, notably krill, that are found in the ocean outside; it is possible that such anomalies will give a clue to the importance of the deep current.

The deeper part of the basin south of the ridge is filled below a depth of 400 metres with very cold bottom water which has in places a temperature as low as −1·94° C., and a salt content raised to 34·87 parts per thousand by the intensive freezing process in winter. Such water would have drained away to the bottom of the ocean outside long before it reached such a high density if it were not for the submarine ridge across the mouth of the sea, and the ridge is partly responsible for the weakness of the influence of the Ross Sea on oceanic circulation compared with that of the Weddell Sea (Fig. 4).

We had no bad weather in the Ross Sea, and the laboratories became piled with specimens which would normally have been hurried below into the hold. It was not easy to carry out an ambitious programme because most of the

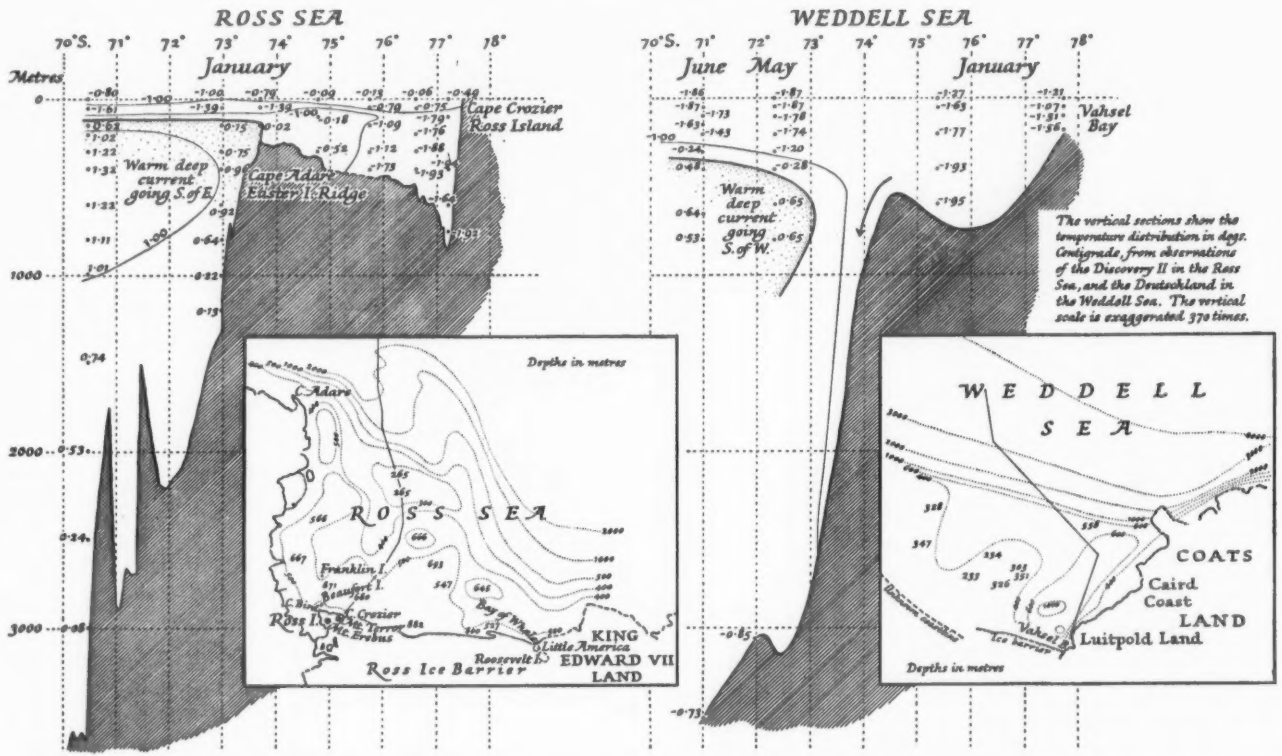



*Fig. 4. Bathymetric charts of the southern extremities of the Ross Sea and the Weddell Sea*

running gear with which we handled nets had been removed to make room for the aeroplanes, and with our huge deck cargo we had very little space. Once we made a successful haul with the otter-trawl, but so much time was lost in getting it inboard that we were not able to use it again. Marr noted that our dredges and the trawl were never hitched on rocks, a fact which points to the comparative absence of large erratic boulders in the Ross Sea; at least they do not stand out from the mud. Round most of the continent the gear continually hitches on rocks.

We had hoped to work a station at the entrance of McMurdo Sound, but a line of pack-ice extended northwards from Cape Bird to Beaufort Island and Franklin Island, and we coasted northwards along it. On the way out of the Ross Sea we entered the pack in 73° 37′ S., 176° 43′ E. on January 27, and reached open water in 71° 57′ S., 178° 38′ E. on January 30. When we were clear we continued our observations 350 miles to the northward, and then turned west to the Balleny Islands.

We sighted Young Island early on February 3, and Captain Hill steamed round the northern end of the group making a running survey. He was not able to complete the survey because the weather set in thick with snow the same afternoon, and remained bad for two days, but many useful observations were made.

Row Island, charted north-east of Young Island, does not exist. Young Island is in approximately the same position as charted, but 18 miles long in a N.N.W.–S.S.E. direction, and only 3 miles wide. Borradaile and Buckle Islands lie nearer to Young Island than the chart shows, the distance between Young and Buckle Islands being 17 miles S.S.E. instead of 35 miles south-east. A new island was found between Young and Borradaile Islands, and this was called Row Island so that the name should not be lost.

When Balleny discovered the group in 1839 with his small schooner *Eliza Scott*, of 154 tons, and the tiny cutter *Sabrina*, of only 54 tons, he was hampered by bad weather, pack-ice, and icebergs, and it is not surprising that our observations should in some ways differ from his. It is however remarkable that he should have described a peak 12,000 feet high on Young Island, which is now almost a featureless plateau of 4000 feet. We found no sign of recent volcanic activity on the four islands we saw. We did not have time to look at Sturge Island, which lies away to the south-east. We lowered a boat near Borradaile Island, but had to turn back soon after we left the ship. Only Captain Freeman, who was lost shortly afterwards when the *Sabrina* disappeared with all hands, has landed on the group.

On February 5 we sailed northwards, and on February 8 passed 2 miles east of the formerly charted position of Emerald Island; the visibility at the time was about 10 miles, and the sounding 2595 fathoms. On February 15 we passed along the east coast of Tasmania; it was high summer, and there were many heath or bush fires, and the smell of the wood-smoke made us impatient for the shore, a feeling which Ellsworth, who had been with us for a month, not unnaturally shared to the full. In Williamstown, at the dock of the Melbourne Harbour Trust, a great welcome had been prepared, and during the next two weeks the people of Melbourne showed us every kindness. We were honoured with visits by the Governor of Victoria, by the late Sir

*Fig. 4. Bathymetric charts of the southern extremities of the Ross Sea and the Weddell Sea*

David Orme Masson, who did so much for Australian Antarctic exploration, and by Sir Douglas Mawson. We owe great thanks to Mr. Eadie, manager of the dockyard, who did a hundred things to make our stay in his yard a pleasant one.

Owing to the time we had spent in the Ross Sea our programme had been modified, and it had been decided that we should work south of Australia and Africa. We sailed southwards again along the 146th meridian; the weather was bad, and after allowing forty-eight hours for the time we were stopped on stations we only averaged 7 knots as far as the ice-edge in 65° S. We missed the Australians: Douglas and Murdoch had made a big contribution to our life in the wardroom, and the five sergeants were just as popular with the P.O.'s.

In 65° 12′ S., 143° 34′ E. there was a heavy long swell from the north-west, and we saw that as soon as the swell entered the outlying streams of brash it steepened to an alarming degree; it may have been partly an illusion, as the ice gave better definition of the crests and troughs, but Marr and I are certain that the swell was made shorter and steeper. We did not keep to the ice-edge all the time as we steamed westwards, but since we had to make our observations at varying distances from the ice and the continental slope, we made two V-shaped cruises to the north, covering a range of soundings from 1000 to 4000 metres.

Before dark on March 20, in 65° 06′ S., 127° 02′ E., and next morning, in 65° 05′ S., 126° 35′ E., we saw what we first took to be a line of icebergs shaped like ice-covered islands some 20 miles to the southward. After examining the formation as closely as we could, we all agreed that it looked more like ice-covered land: the ice stood up, though to no great height, all along the horizon; at several points it appeared to shelve gently to the sea and at others there were steep ice-cliffs; and it seemed that there were valleys curving back into low ice-covered land. Wilkes also saw land here when he was approximately 2 miles north of our position in 1840. If he saw the same appearance as we did it is not at all surprising that he claimed to have sighted land. It is however fairly certain that we were mistaken, because Mawson's pilots, when they flew to 8000 feet some 45 miles W.N.W. of our second position, reported land bearing south-east at a distance not less than 95 miles. This observation places Cape Goodenough some 50–60 miles roughly S.S.E. of us, and it is very unlikely that we could see it.

We could not push southwards because new ice was forming rapidly, and at 10 a.m. the air temperature was only 6° F. The soundings at our farthest south points on March 20 and 21 were 1022 and 800 fathoms. After reaching 65° 26′ S. in 120° 54′ E. on March 22, we went northwards for a few days, returning to the ice in 64° 23′ S., 106° 33′ E. on March 25. As we approached the shallow water north of the Shackleton ice-shelf the pack advanced northwards, and we finished the westward voyage in 63° 59′ S., 100° 11′ E. on March 26.

The *William Scoresby*, a month to six weeks earlier, had seen a good deal of the Antarctic coast-line. With Mr. G. W. Rayner in charge and Captain C. R. U. Boothby in command, she had spent the whole summer marking

whales, but on February 12, being in about 103° E., she went to look at Bowman Island, sighted by Mawson in 1931. The first position to be published for the island was 65° 09′ S., 103° 15′ E., but this has since been changed to 65° 09′ S., 101° 15′ E. The *Scoresby's* navigators came away convinced that there are islands in both positions. The first, 700 feet high, was seen from 64° 49′ S., 103° 18′ E., bearing 182° at a distance of 19½ miles, and the second from 64° 45′ S., 101° 31′ E., bearing 202° at a distance of 30 miles. Both islands were surrounded with close pack-ice.

On February 24, some 800 miles to the westward, the *William Scoresby* entered the MacKenzie Sea, at the eastern end of MacRobertson Land, and reached a position 68° 45′ S., 70° 42′ E., 31 miles south of that reached by the

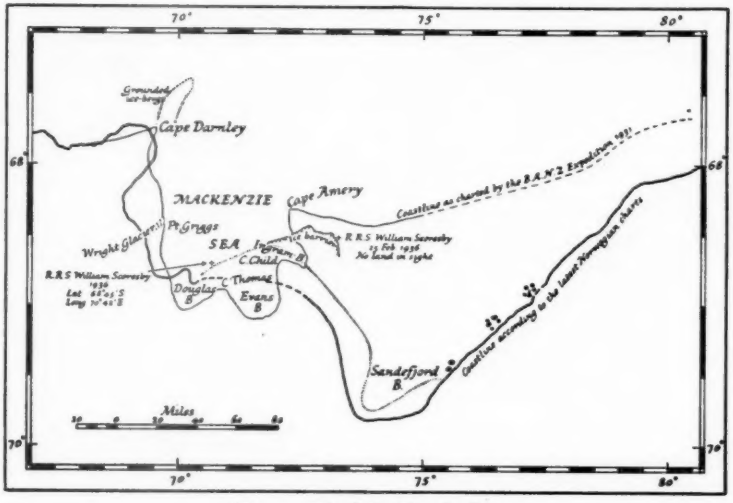



*Fig. 5. The MacKenzie Sea*

*Discovery* in 1931 (Fig. 5). On the next day she followed the barrier to the east, keeping 1 or 2 miles off. At noon she found the barrier trending away to the S.S.E., and from where she was lying, in 68° 33′ S., 73° 16′ E., a mile or two east of the barrier, no land could be seen in any direction though the visibility was excellent; there was also a heavy swell from the south-east. The *Scoresby* had passed 10 miles south of the reported position of Cape Amery, and it is evident that the chart of the Norwegian Whalers' Association is more accurate than Mawson's aerial sketch in this neighbourhood.

The *Scoresby* had then to turn back to the west. Her long stay in the Antarctic was made possible by the British and Norwegian whaling companies, who had agreed to supply oil fuel from their floating factories, and at this time the factories were fishing off Enderby Land.

On February 26 a landing was made at the Scullin Monolith, where Mawson landed in 1931. Rayner climbed to 800 feet, and saw the land to the south completely ice-covered. Next day they visited Sheehan Nunatak just inside

the eastern limit of Kemp Land (Fig. 6); here they found that what had appeared to Mawson from a distance to be a nunatak was one of a group of islands. Behind the islands and extending 6 or 7 miles to the southward, they found a bay some $3\frac{1}{2}$ miles wide. Surrounded by rocky headlands rising to 800 feet, ice-cliffs, and islands, the bay affords excellent shelter. Captain Boothby and Lieutenant Macfie, R.N.R., made a rapid running survey, but they were not able to find a suitable anchorage, all the shores being steep to. There were many easy landings. Rayner examined a large off-lying island which has been called Bertha Island; it had at first appeared to be part of the mainland, but when he had climbed to the south side it proved to be cut off

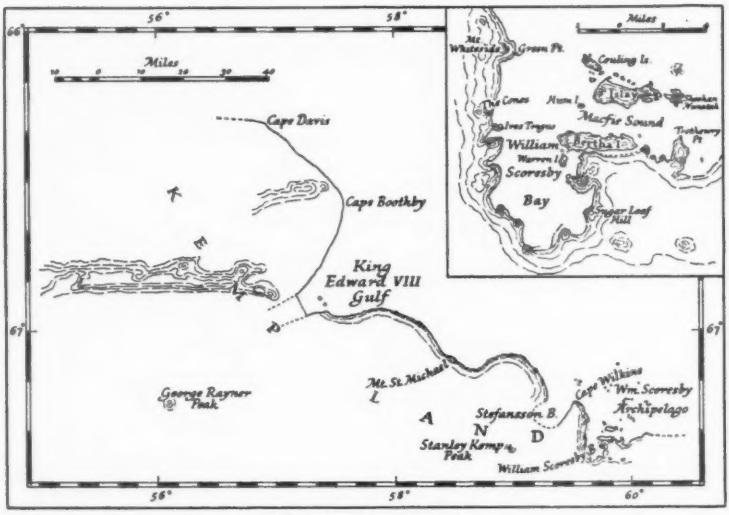



*Fig. 6. Kemp Land*

by a narrow channel, for the most part frozen. Beyond the channel the inland ice-cap sloped down to sea-level between two rocky headlands. A few Emperor and Adélie penguins were seen, and there were plenty of Weddell seals. The bay was called William Scoresby Bay; it lies just to the westward of Oom Bay, seen by Mawson, and in 59° 40′ E. it extends to 67° 26′ S.

Immediately to the westward again a third bay was found; it was about the same size as the one examined, but it was not entered. This should perhaps be called Stefansson Bay, a name that Mawson has used for what he took to be a more general indentation of the coast west of Sheehan Nunatak. West of the bay the coast trends north-west to a cape in 67° 05′ S., 59° 00′ E. with a rock standing $2\frac{1}{2}$ miles offshore W.N.W. Between the cape and 66° 56′ S., 58° 00′ E. there is a bight with a conspicuous point in the middle which was called Mount St. Michael. West of 58° E. the coast trends slightly south of west into a deep bay at the head of which there is an ice-face 4 or 5 miles across.

When the ship was lying about 8 miles off the ice-face, in 66° 48′ S., 57° 37′ E., a high peak was observed at a very great distance bearing 236°, and between the peak and 9° to the northward low ice-covered land stretched to the horizon. Looking to the west there were foothills rising inland to peaks of 3000–6000 feet, and farther north was the end of the Nicholas range seen by Mawson in 1930. From the ice-face the coast trends N.N.E. to Cape Boothby in approximately 66° 34′ S., 57° 34′ E. Further progress along the coast was hindered by pack-ice which extended 20 miles to the northward, and seeing the coast trending away to the north-west to the reported position of Cape Davis, the *Scoresby* turned northwards. On March 6 she was again in sight of land, working $2\frac{1}{2}$ miles off the ice-cliffs south-west of Cape Ann, Enderby Land. Shortly after she followed the whales northwards, and arrived at Cape Town on April 3.

At the same time the *Discovery II* was making a line of observations between the Shackleton ice-shelf and Western Australia. She was to go southwards again in May and June, but in the meantime was to make a voyage across the Indian Ocean in 32° S. In spite of the number of ships which cross backwards and forwards over the southern part of the Indian Ocean very little was known about it, particularly about the eastern half. No deep-sea temperatures had been measured there since the voyage of the *Gazelle* in 1876, and her observations could not be reconciled with those we had made farther south.

The soundings we made show as many as six submarine banks or ridges, of depths varying from 600 to 1400 fathoms, spaced almost evenly across the ocean, instead of the one plateau we had expected near the St. Paul and Amsterdam Islands; they show so many new features that it will not be possible to do much with them till other lines of soundings are run. The temperature measurements and water samples were more satisfactory; they throw some light on the bottom topography and reveal a more understandable water circulation.

The biological work was perhaps the most notable achievement. In addition to routine observations as many as forty hauls were made with our largest nets, most of them with the $4\frac{1}{2}$-metre net, whose mouth has a diameter of nearly 15 feet. The deepest layer fished was that between depths of 2000 and 3400 metres; the importance of the work lay in the fact that the net was closed while it was still in the deep layer and not hauled open to the surface, and such large nets have rarely been closed successfully before. Owing to a great improvement which Marr introduced in the method of bringing up the closed net, many rare specimens were obtained in excellent condition. The fauna of the great depths proved to be very poor compared with that of the first 1000 metres.

Our next piece of work was to make observations west of Cape Town to the Greenwich meridian, and along this meridian to the pack-ice; the same lines were to be repeated in the following spring and autumn, and with the three sets of observations we hoped to measure the seasonal changes in the water movements and plankton. On the Greenwich meridian extra nets were to be fished to a depth of 1500 metres.

We left Cape Town on May 18 and turned southwards on May 23. North

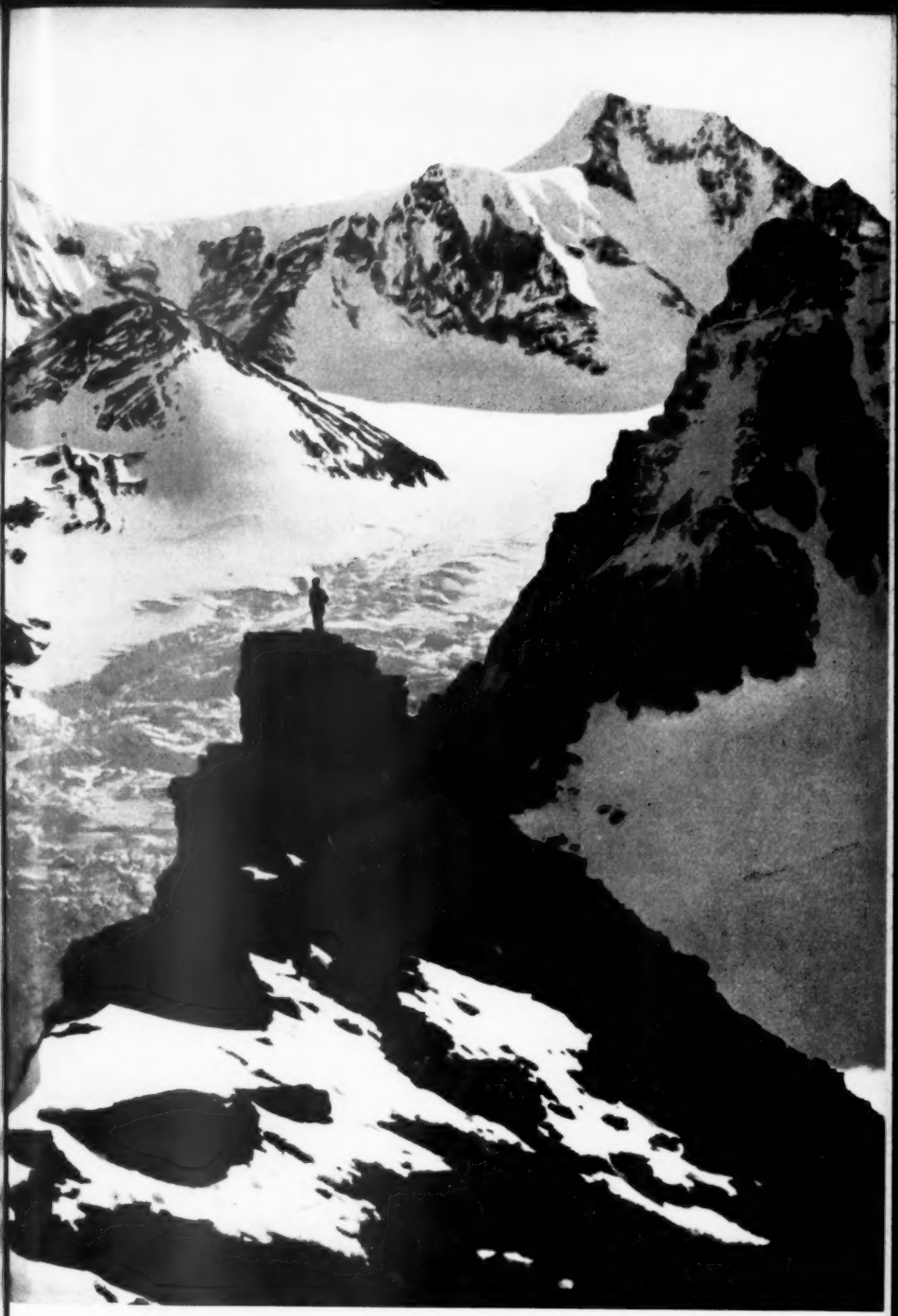
of Bouvet Island the weather was unusually bad, but we managed to complete the programme. Between 41° 50′ S. and 42° 30′ S. we found a new bank with only 369 fathoms; since our return German oceanographers have named it the Discovery Bank. The first signs of young ice were seen in 56° 10′ S. on June 2, but it was not till 57° 33′ S. that we encountered any large area. We then passed intermittently through areas of ice and water, but the ice patches became heavier and more extensive, and in 58° 45′ S. it was judged unwise to proceed farther. The air temperature had fallen to 7·5° F. below a heavy overcast sky, and we hurried to finish the work before we turned northwards.

The results proved well worth our pushing so far; we had just reached the northern edge of the warm deep current which flows westwards into the southern part of the Weddell Sea from the western half of the Indian Ocean, and we were able to show that a greater volume of warm water pours into the Weddell Sea in winter than in summer. The greater movement is probably related to a stronger outflow of cold bottom water and the freezing of sources of fresh water, but our data bearing on the question are not yet fully examined. In summer the northern boundary of the current lies some 200 miles farther south, and temperatures as high as our winter values are only found in the main axis of the current in 64–65° S. Farther east the water was slightly warmer, and on June 12 we reached 59° 12′ S., 17° 02′ E. without much difficulty. From this point we worked a line of stations northwards to South Africa.

At all our stations in the Weddell Sea current, south of 54° S. on the Greenwich meridian and south of 50° S. in 19° E., we took enormous numbers of young krill near the surface, and there is no doubt that much of the area covered by the current east and west of our lines was just as rich. Marr finds that the production of krill in the Australian and Pacific sectors is of a very low order compared with this, and it seems that the Weddell Sea is by far the most important nursery of whale food. The very abundant data relating to the problem are still under consideration, but there are indications that with the approach of winter the adult and sub-adult krill sink to the level of the warm deep current, and in the depth of winter the surface waters are practically devoid of them. Such a sinking movement on the rich whaling-grounds of the western half of the Indian Ocean sector will result in large numbers of older krill, about to produce eggs, being carried southwards and then westwards into the southern part of the Weddell Sea, and in this way the Weddell Sea can be maintained as an enormous centre of production.

When we arrived at South Africa the ship was put into dry dock at the naval base in Simonstown, and we spent the months of July and August preparing for a fresh start in September. I cannot pass over this period without saying how grateful we are for the kindness with which we were received. Above all we owe thanks to the naval commander-in-chief, Admiral Sir Francis Tottenham.

We sailed again on September 15, once more to the Greenwich meridian and southwards. This time we met heavy pack-ice in 53° 18′ S., and on September 28 we turned westwards, making tacks north-west and south-west across the region north of the pack. On October 15 we arrived at South Georgia and anchored in Grytviken, the whaling-station where most of our



*Sugarloaf Peak, South Georgia, 7300 feet*

*Gibbs Island and the Narrow Island peninsula*

*Cape Bowles, Clarence Island*

*O'Brien, Eadie, and Aspland Islands*

whale observations have been made. Leaving almost immediately, we made a short survey of the conditions on the whaling-grounds near the island. During one of our visits to Grytviken we made two short excursions towards the central mountain chain of the island. A small climbing party could find a great deal to interest them there, though they would have to be prepared for very difficult weather conditions.

We found Brian Roberts, of the British Graham Land Expedition, studying birds in South Georgia, and on our next cruise, during which we were to visit Port Stanley in the Falkland Islands, he sailed with us. We first went north-west to the Antarctic convergence and then southwards. We reached the pack-ice across the northern part of the Weddell Sea in 61° 13′ S., 42° 42′ W., south-east of the South Orkney Islands, on November 10, and we followed it west and south to the Darwin Islands off the east coast of Joinville Island. On November 13, Ommanney, Roberts, and I landed on Clarence Island half a mile east of Cape Bowles while Marr made a series of dredgings 2 or 3 miles offshore. On November 17 we reached Port Stanley and met the *Penola*.

Our next task was a survey of the trawling-grounds on the Patagonian shelf, covering the region in which the *William Scoresby* has worked for three seasons with the commercial otter-trawl. Early in December we were back near South Georgia, repeating various series of observations over twenty-four-hour periods to investigate the vertical movements and distribution of the zooplankton in adjacent regions of rich and poor zooplankton. This period was the climax of the commission, and 350 nets were fished and 850 water samples taken in three days. We also made observations on internal waves in the sea, and measured deep and shallow drifts from a buoy anchored in 1860 fathoms. We found relief by going ashore to examine seals, and returned to Grytviken in time for Christmas.

In January 1937 we visited the South Shetland Islands, and Captain Hill and his officers started to complete the survey made by Captain Nelson during the *Discovery II's* previous voyages. The scientists helped where they could, and landed wherever possible to examine the coast and to make counts of the seal population. On January 6 a party of five men were landed inside the North Foreland, at the north-east corner of King George Island, to survey Esther Harbour, and Ommanney stayed with them to make biological observations. The ship went round to the south coast and worked in King George Bay (Fig. 7).

When this part of the island was finished we went back to the North Foreland, but, being held up by fog, did not arrive there till January 15. We then made the alarming discovery that the camp was deserted, and found that the party had gone for a short journey in their boat and had not been able to get back. We began to search at once, but soon after midnight we were driven from our anchorage by a westerly gale. It was evident that we must search every bit of the coast-line in the neighbourhood as soon as the weather moderated, and as we could only lower two whalers ourselves we wirelessed for help. Assistance came very quickly; H.M.S. *Ajax*, carrying the Governor of the Falkland Islands from South Georgia to Port Stanley, came southwards at 26 knots; Mr. Andersen, manager of the whaling-factory *Kosmos II*, sent a whale-catcher, and the *Penola*, on her way southwards, altered course. We

were able to lower boats again at 8.30 a.m. on January 18, and at seven o'clock the same evening the missing men were sighted on a snow slope above a small beach some 6 miles to the westward. Shortly after we were very thankful to get them safe on board.

Next day the survey was started again, and we were once more in King George Bay, in Admiralty Bay, and off the north coast. On January 31 we were able to begin the examination of Gibbs, Aspland, O'Brien, and Narrow Islands, which lie S.S.W. of Elephant Island. Their coasts are mostly precipitous rock walls, and they have small ice-caps. Between O'Brien and Aspland Islands we found an island which has not been mentioned before, and Captain Hill has called it Eadie Island. Narrow Island was found to be joined to Gibbs Island by a low shingle and boulder spit, some 50–80 yards

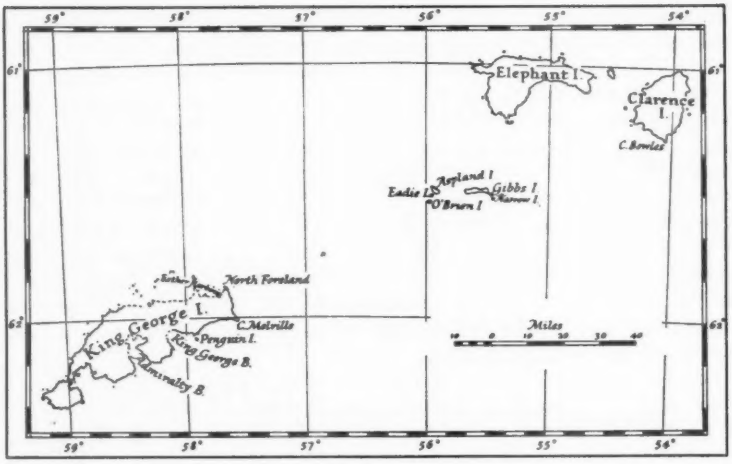



*Fig. 7. South Shetland Islands*

long and standing 2 or 3 feet above the level of high tide. With some difficulty we were able to land on the south coast of Gibbs Island, on a steeply shelving beach about half a mile from the spit. Marr just managed to scramble ashore on the Narrow Island peninsula; we could not land on the spit because there was too much sea and some off-lying boulders.

Our work ashore had by this time given us a large collection of rocks, mosses, lichens, a few flowering plants, algae, mites, and collembola. The counts we had made of seals were of particular interest because of the large number of elephant seals. During the last forty years there have been very few records of these seals visiting the South Shetlands, and it would seem, at first, that there has been an enormous increase in the population just recently. This cannot however be attributed to breeding there, because the number of pups was only 4 per cent. of the total. It seems very likely that the seals had been taking advantage of the particularly warm and ice-free conditions of this season to come farther south than usual to moult. It must also be remembered

that the counting had been one of our main objects in landing, and the earlier observations have been more casual.

After leaving Gibbs Island we looked at Clarence Island, but the weather was not good enough for survey work, and after waiting two days we went to the South Orkney Islands. We anchored in Scotia Bay, Laurie Island, on February 6, close to the meteorological station founded by Bruce and maintained by the Argentine Government. We found the spit on which the station is built quite free of snow, and we were told that both spring and summer had been unusually warm. The ice had gone out so early that they had not been able to get to the penguin rookeries for eggs. The whole staff of five were waiting to be relieved, and a new staff was coming down in a steamer diverted from a regular run between Buenos Aires and Ushuaia. Captain Hill spent four days making astronomical observations, and we examined the coast-line to the east and west. We found here, as at the South Shetlands, an unusual number of elephant seals.

On February 11 we visited Graptolite Island, a huge penguin rookery. Dr. Harvey Pirie, in 'The voyage of the *Scotia*,' gives an interesting account of how he saw the penguins arrive at the beginning of the nesting season. They must have landed on the north coast of Laurie Island, and he saw them crossing the narrow part of the island north of Fitchie Bay in hundreds, and then marching across the frozen strait like regiments of soldiers to take up their positions on Graptolite Island. It is surprising that they should take this direct route from the north, when it would surely be less laborious to swim round the end of Laurie Island. It was not a pleasing scene that we saw; only backward chicks and parents were straggling in the desolation left by the thousands that had already taken to the water. We looked for graptolites, the fossils that give the island its name, but could not find any. We brought off several hundredweight of shale, and Dr. Bulman has agreed to look at it.

We next made a few lines of soundings, and then anchored in Borge Bay in Signy Island. Close by the abandoned whaling-station we found small patches of grass, colobanthus, and liverwort, this being we believe the first record of flowering plants and hepatics on the South Orkneys. The one other reference, by Weddell, to a patch of short grass on Cape Dundas, the eastern extremity of Laurie Island, was not confirmed by the *Scotia* scientists. Near the north-west coast of Signy Island we found scattered clumps of an agaric, numbering upwards of one hundred individuals to a cluster, but unfortunately the specimens of these were lost on the long walk back to the boat. About a half of the coast-line was examined.

After a visit to Sandefjord Bay on February 14, we anchored for a few hours near Penguin Point on the north coast of Coronation Island, and Marr was able to land with great difficulty at two points, and at one point on the adjacent Governor Island. This was the end of our work at the South Orkney Islands, and we left on February 15, working lines of stations to the Falkland Islands and South Georgia.

After more work round South Georgia we started southwards again across the eastern part of the Weddell Sea, passing 10 miles west of Southern Thule, the southernmost island of the South Sandwich group. In addition to the routine work we were fishing a 2-metre net every day in the layer between

depths of 1000 and 1800 metres. The greatest numbers of krill larvae were found in the current which flows eastwards across the Atlantic Ocean from the northern part of the sea; there were none in the middle of the sea, and only few in the westward current near the continent.

We passed through some newly formed ice in 67° 16′ S., 19° 28′ W. on March 16, and met heavy pack-ice in 69° 50′ S., 15° 29′ W. on the following day. After working a station we turned north-east, but shortly afterwards, to get clear of streams of ice, we had to turn northwards. There was a heavy stream between 68° 06′ S., and 67° 54′ S. in 15° 04′ W., and streams of light ice were found as far north as 66° 43′ S. In this latitude we turned east and then south of east. It was our last cruise in cold weather, and one of the most unpleasant; there was a persistent south-west wind of 20–25 knots, and the temperature kept between 10° and 15° F. On March 21 we reached 67° 14′ S., 00° 40′ E., and from this point we turned northwards to make our third series of observations along the Greenwich meridian and 34° S.

I have not had space to describe one of our stations in detail, but it is not difficult to picture what happens. Almost every night the ship is held steady in the wind, and the telegraph rings constantly as the long wires are lowered vertically. Disaster can come in a dozen ways, and only care and patience stave it off. Reeling on a new wire was a laborious ritual, and a close examination was made after any hint of damage. In bad weather we were generally a bit on the safe side. If any gear suffered it was usually a net; they are more fragile, generally made of fine silk, and not so easily controlled. Even the nets mostly had a long life, and they were patched and mended till Ayres, the netman, was not sorry to see them go. After the vertical work, nets were towed horizontally and obliquely over the stern. At the end of our second summer Marr and Ommanney could fish some of the nets safely till the weather made it impossible to stay on the poop. I believe Ayres was on deck for every station we worked.

We arrived at Cape Town on April 7, and the *William Scoresby* was only a fortnight ahead of us. This season, in charge of Dr. T. J. Hart and Captain Boothby, she had only sighted land once, having spent the late summer in the eastern part of the Atlantic Ocean. She had marked a record number of whales, and during the two seasons the number marked by the *Scoresby*, and by Mr. H. F. P. Herdman and Mr. E. R. Gunther from the hired whale-catcher at South Georgia, had raised the total to 4500.

On leaving Cape Town the *Discovery II* went back to the Greenwich meridian and continued the line of observations northwards beyond the equator; water samples were taken night and morning, and once a day Marr fished the great depths with the $4\frac{1}{2}$-metre net. After calling at St. Vincent we tried to take live deep-sea fish for the Zoo, but this, I am sorry to say, was the least successful part of the commission. We tried hard, and our last station was worked on the day before we arrived at Plymouth.

We were welcomed at Plymouth by Vice-Admiral Sir Percy Douglas and Dr. Kemp, and by our new director, Dr. Mackintosh. We arrived back in London on 27 May 1937, and tied up alongside the *William Scoresby* in St. Katharine Docks.

# APPENDIX: ADDITIONAL NOTES ON THE LANDINGS IN THE SOUTH SHETLAND GROUP AND KEMP LAND

FROM NOTES BY J. W. S. MARR AND G. W. RAYNER

*King George Bay, King George Island.* On the west side of the bay, east of Cape Lion's Rump, there is an extensive beach, quite a mile long, on which it will be possible to land in all but strong south-east winds. Behind the beach there is flat land, sometimes several hundred yards deep, and then slopes of volcanic tuff leading to the inland ice-cap; this falls with an easy gradient in heavily crevassed and dirty ice-slopes. The locality seems to have been used extensively in the old sealing days; there is much driftwood, stout planks, various parts of boats, broken and complete oars, and an old faggot-type ship's fender. Out of reach of the elephant-seal wallows, the vegetation was comparatively rich; at about 100 feet we came upon a patch of rich green grass fully 50 square yards in extent; there was also a luxuriant growth of moss. There are large rookeries of Adélie penguins and a small Gentoo rookery. The seals are mostly elephant seals, but there are a few Weddell seals. On the east side of the bay behind Penguin Island there are long shingle beaches with fully a square mile of low ground behind. There are extensive raised beaches. The coastal cliffs between the beaches are all of lava or basalt, but the shingle is composed in the main of igneous (granitic) rocks of great diversity. There are large rookeries of Adélie penguins, and elephant seals.

Penguin Island is difficult to land on in all but calm weather, as the shores are formed of large boulders. The southern half of the island is a volcanic cone 550 feet high, and the northern half a large low plateau only about 50 feet high. The volcanic cone, which has a crater a third of a mile across and 200–300 feet deep, appears to be part of the rim of a much more extensive crater, for the most part destroyed. The present crater probably belongs to a later eruption; on the east side of the bowl there is a lava plug 100 feet high, and in the middle a secondary cone rising about 100 feet with a small crater 80 yards across and 20 feet deep. There is another crater in the plateau which forms the northern part of the island; it resembles an old quarry, an almost perfect circle 200 yards across and filled below a depth of 50 feet with deep water. There was very little snow on the island, and clean fresh water was difficult to find.

*The north coast, King George Island.* The North Foreland is a low plateau, about 80–100 feet high, projecting northwards for at least a mile from the higher ice-capped land behind. On its west side there are extensive shingle and sandy beaches on which a landing can be made in all but strong north to north-west winds. The east coast bristles with rocks, and except in a flat calm it would be dangerous to approach it even in a boat. West of the foreland there is a large bay studded with reefs, and then a steep bluff headland, which because of its yellow colour has been called Brimstone Peak. On the east coast of the peak we found the wreck of a stout wooden sailing vessel, now nearly overwhelmed by scree. Esther Harbour lies about a mile to the westward of Brimstone Peak, beyond a rocky promontory jutting out about 200 yards from ice-cliffs which continue the coast-line to the westward. Though exceedingly exposed, and partly filled with brash ice, its approach seen from the top of Brimstone Peak did not appear to be so beset with dangers as the large bay between the peak and the North Foreland. The whole of the north coast is very inhospitable: there was evidence of frequent rock falls and landslides. During the ten days spent by the survey party on the small beach some 5 or 6 miles west of the North Foreland mud and stones fell very frequently. Between the North

Foreland and Cape Melville there had been several enormous landslides, obviously not long before our visit.

*Gibbs Island.* The coast of Gibbs Island, like those of the neighbouring Aspland, O'Brien, and Eadie Islands, consists for the most part of sheer and inaccessible cliffs crowned with a light mantle of highland ice; the general features of the Narrow Island peninsula, which is joined to Gibbs Island by a low spit, are the same. The coast is very exposed, offering little or no shelter to a vessel, but there is a considerable embayment on the south coast near the spit. The best landing is in a tiny cove 100 yards west of the spit; the cove is probably sheltered in all weathers, and it is about 20 yards square with a few yards of sandy beach at the head. There is only one beach on the north coast, but it is protected by off-lying rocks, and in a moderate swell we could not land there. A landing was made with difficulty on a small beach on the south coast, half a mile west of the spit, on a fairly calm day. There are several penguin rookeries on the island; those on the south coast, west of the spit, being Ringed penguins. The vegetation is extremely poor, probably because the islands are so exposed and precipitous; it presents an extraordinary contrast to the comparatively luxuriant vegetation of the more westerly parts of the South Shetland Islands.

*Clarence Island.* The landing was made on a shingle beach about half a mile east of Cape Bowles, the southernmost point of the island. It was not a very safe place because there was a high cliff with an ice-cap behind the beach; it would be difficult to land there in anything but very calm weather as there is little shelter. Between the landing-place and Cape Bowles there is an extensive rookery of Ringed penguins on some 8–10 acres of low and bare scree slopes. Along part of the coast between the scree slopes and the sea was a miniature ice-foot glacier 10–20 feet high; this it seemed might partly be fed by winter avalanches from the high ground behind the scree slopes. Only two seals were seen, and there was no driftwood.

*Kemp Land, Bertha Island.* The island is about 3 miles long from east to west. It is low in the east, but a series of rocky ridges run across it from north to south, and these become higher towards the west till the last, which falls steeply to the sea, reaches 400 feet. A report by Professor C. E. Tilley on the rocks found on the island is in preparation. There was little snow on the island, but freshwater pools were found in the hollows among the hills. Patches of moss were found in favoured positions on the northern slopes. During the night of February 27 the air temperature fell to 10° F.

## DISCUSSION

Before the paper the CHAIRMAN (Professor KENNETH MASON) said: The paper to be read to-night deals with the Antarctic voyages of R.R.S. *Discovery II* and R.R.S. *William Scoresby*, 1935–37. It is by Dr. G. E. R. Deacon, chief scientist on the fourth commission of *Discovery II*. Dr. Deacon has asked me not to say too much about him, and so I will call upon him straight away to read his paper.

*Dr. Deacon then read the paper printed above, and a discussion followed.*

The CHAIRMAN: I will ask Mr. G. W. Rayner, who was in charge of the *William Scoresby*, to say a few words about his experiences.

Mr. G. W. RAYNER: In adding to Dr. Deacon's remarks about the *William Scoresby* I must tell you again that the *William Scoresby's* work during the commission of 1935–36 was to mark whales in that part of the Southern Ocean lying to the south of the Indian Ocean. In this region there are two major whaling-

grounds, a westerly one off Enderby Land and an easterly one off Queen Mary Land. We had spent the beginning of 1936 on the Queen Mary Land grounds, but in the middle of February I decided to move westwards so as to make contact with the ships of the whaling-fleet working off Enderby Land before the season closed. In our experience few whales were to be found between the two whaling-grounds, and to make the passage as short as possible we laid a great-circle course, but expected to be held to the north by pack-ice. We met no pack, and on February 24, early in the afternoon, Cape Darnley appeared ahead. On our port bow was the MacKenzie Sea, open, and as far as we could see free of ice. This seemed too good a chance to miss, so I decided to sacrifice a few hours of our whale-marking programme to a short incursion into this bight, and, following Biscoe's maxim, we stood to the southward. After steaming southwards until the light failed we lay to for the night whilst I attempted to take a few hydrological observations. One of those swift and violent gales which spring up in these waters with such fury and rapidity made this almost impossible, and after three hours' struggle with frozen gear I abandoned the attempt. We followed the eastern side of the MacKenzie Sea some way northwards the following day, found Cape Amery non-existent, and at noon turned once more to the west to spend the night off Cape Darnley.

After a period of gales and general unpleasantness the next day brought calm and sunshine. We steamed westwards along the coast of MacRobertson Land and, passing Murray Monolith, arrived off Scullin Monolith about two o'clock in the afternoon. Scullin Monolith is a crescent-shaped massif enclosing a north-facing bay: to the south it falls sheer to the ice front which breaks against it and flows round each side. We had now been in our ship for three months without a chance of getting away, and here seemed to be a golden opportunity for a short escape. Accordingly we went ashore, and working in relays almost the whole crew was able to have at least a couple of hours' exercise, scrambling about among the penguins. This short spell ashore was a delightful and treasured interlude giving us a distinctly different aspect of our environment. After this unexpected break in sea routine we hurried westwards.

The next day land was again in sight to the southwards, and early in the afternoon, as we drew closer and the mirage cleared, we could see that part to which Mawson had given the name Sheehan Nunatak, looking quite different from what was laid down in the chart. The conditions were so suitable that I decided to approach and have a closer look; we again turned southwards, and after steaming through an archipelago of small islands reached the bay we named Scoresby Bay. Whilst I went ashore to collect rock specimens the ship made a rapid running survey of the neighbourhood. I was taken off again after dark and the ship anchored for the night, during which we had one of the finest displays of the Aurora I have seen. The following day we steamed along the coast of that part of the Antarctic continent which has long been named Kemp Land. It is one hundred years ago this year since Kemp Land was first brought to the notice of this Society, but no one had really seen this stretch of coast until we cruised along it. The whole coast was clear, and conditions ideal for its exploration; and it was with great reluctance that I turned my back upon it. At half-past three the following morning we were once more in the open ocean chasing whales on the Enderby Land grounds.

Mr. H. G. MAURICE: In the face of so many experts it is rather difficult for me to open this discussion, but I am proud to be the first to have the opportunity of congratulating Dr. Deacon on his lecture, and him and his party on the work that they have done on this commission. Everybody must have been led to the reflection that the work carried out by the staff of the *Discovery* Committee in

the Antarctic is nobody's picnic. It is a very hard life, and I think you must have been struck by the cheerful endurance of the party and, as I was, by their faithful adherence, in spite of one dramatic interruption, to the programme laid down.

I know something about such programmes. Having been for eighteen years, until July last, President of the International Council for the Exploration of the Sea, and for twenty-six years Fisheries Secretary in the Ministry of Agriculture and Fisheries, I have been in close contact with this kind of work for a long time. What has interested me always in watching *Discovery* work, with which I have also had some connection, has been that you find in these whaling investigations the same technique as is applied to fishery investigations. It is what I call the new oceanography, which began with what were originally called the North Sea investigations, when the countries of western Europe agreed, in 1902, to combine to carry out fishery investigations. That work, so far as Great Britain was concerned, was first put into the hands of the Marine Biological Association of the United Kingdom, of which Dr. Kemp is now the Secretary, and Director of the Plymouth Marine Biological Station. The work was set on foot by a body of men enlisted by the Marine Biological Association. They were, in this country, the pioneers of the new oceanography which consists in studying the animals of the sea in relation to the medium in which they live and to their environment as a whole. It is perfectly illustrated in the work described by Dr. Deacon: the study of the water at different places and depths and the study, by means of special nets, of all living creatures at different depths. Its technique is still being developed, as you will have noticed from the fact that Mr. Marr has just invented a new method of closing the net when at great depths so as to be sure that the sample taken at those depths is truly representative.

I would like to take the opportunity here of paying a slight tribute to one who was connected with the *Discovery's* work and was, before that, for many years one of my colleagues; a man who was one of the pioneers of the new oceanography and who contributed much to its technique. I refer to Mr. John Oliver Borley, who recently died after having done most distinguished work in this field for some thirty-five years. During all that time work broadly similar to that with which Mr. Deacon's lecture deals has been going on, and in this country in particular oceanography in this practical form has been carried on probably more effectively than in any country in Europe. In saying that I do not want to make odious comparisons but to emphasize the importance of our contribution. There is the Marine Biological Association of the United Kingdom, which I venture to say maintains the most famous biological station in the world. There is the home station of the Ministry of Agriculture and Fisheries at Lowestoft, the station of the Fishery Board for Scotland in the Bay of Nigg, Millport, and the Dove Marine Laboratory on the coast of Northumberland; also smaller stations on the coast of Wales. All these are carrying out practical work. In addition there are the *Discovery* expeditions, of which there have been four, in the Antarctic, doing corresponding work in a different field.

Curiously enough, I believe you will find that few people in this country realize that we are doing oceanographical work on an extensive scale leading up to practical results. It is very largely as a result of the work done by the *Discovery* staff that we were able the year before last to bring about an international whaling convention and were able to convince those concerned of the necessity for practical measures for the protection of the whale; and again to carry that a stage further in the year which has just ended. Equally, work of this kind was the foundation of the international convention for the regulation of meshes of

fishing-nets adopted the year before last. But practically nobody in this country knows anything at all about that work. I venture to doubt whether any Cabinet Minister to-day would be able to give you an approximately intelligent explanation of the work and its finances, mainly by the Development Commission in the case of fisheries and by the whalers in the case of the *Discovery* investigations, for which the Government gets credit abroad, while very little is known about it at home.

The CHAIRMAN: Dr. Stanley Kemp was Director of the *Discovery* Committee from 1934 to 1936, and I will ask him to address the meeting.

Dr. STANLEY KEMP: I am glad to have this opportunity of paying a tribute to Dr. Deacon and his colleagues for the splendid work that they did on the fourth commission of *Discovery II*, and to Mr. Rayner and the personnel of the *William Scoresby* also, for their remarkable success in whale-marking, and for the discoveries they made on the Antarctic continent. I was in the Antarctic during the first two voyages which the *Discovery* Committee planned, and it has been a great satisfaction to me to see how methods have continually been improved and perfected, until to-day long programmes can be put through and numbers of accurate observations taken with almost machine-like precision. That is what we have been aiming at all along: because it is only possible to make a comprehensive survey of the conditions in the Southern Ocean by the constant repetition of observations taken in exactly the same way. The work is very far from being exciting: it tends to a dull and monotonous routine, and only the scientific staff on board can appreciate the ultimate value of what is being done. To the crew it is just the same wearisome round for ever repeated, while to the ship's officers the only variation is in the anxiety which wind and ice conditions may bring. I would like to place on record our very high appreciation of the services of the ships' companies and of the gallant way in which they have supported the work and done their utmost to bring success to the scientific programmes.

A word about whale-marking, which, as you know, is a method by which the migrations of these great mammals can be traced. It was only after some years of experiment that a practicable method of marking whales could be found, and it is to Mr. Rayner, more than to any other member of the staff, that our success is due. Marks made of stainless steel are now used in this work, and on the cruises made by Mr. Rayner, Mr. Herdman, Mr. Laurie, and Mr. Gunther some five thousand whales have been marked. Returned marks, received from the whaling-ships, have been coming in and will continue to come in for some years yet. In due course we hope to have a good idea of the migrations of the southern whales, and that is a matter of both scientific and economic importance.

Dr. Deacon has spoken of some of the chief incidents in the fourth commission of *Discovery II*; but when he told you, in his unimpassioned way, of how a party was marooned for twelve days on King George Island, I wonder whether you realized how very near we were to tragedy.

The deviation for the relief of Lincoln Ellsworth and Hollick-Kenyon meant the abandonment of very carefully laid plans for a circumpolar cruise. At the time I regarded it with the greatest dismay, but, as Dr. Deacon has told you, the Ross Sea proved to be of most exceptional interest. Hydrographically, in the constitution of its water masses, it is quite different from anything else in the Antarctic, while Mr. Marr, who is a wizard at handling complicated biological apparatus, has been able to show that its fauna is also very peculiar and has most important and interesting features.

I heartily congratulate Dr. Deacon and Mr. Rayner on their extremely successful work.

Dr. N. A. MACKINTOSH: I do not know that I can add very much to what Mr. Maurice and Dr. Kemp have said, but I should like to congratulate Dr. Deacon on his account of the fourth commission of *Discovery II*, which was carried out under his leadership. The programme of *Discovery II* covers a wide field of research, but the hydrological side of it is, in a way, the foundation and the starting-point of all our work. Dr. Deacon is a hydrologist, and it is very largely owing to his personal work that we have perhaps a sounder knowledge of the currents and water masses of the Southern Ocean than of almost any other sea in the world, including even the north Atlantic. During the voyages of *Discovery II* most of the time is spent in hard routine work, nearly all of it out of sight of land; but, as Dr. Deacon has shown, these periods are interrupted by interesting incidents, views of sometimes magnificent scenery, and adventures of one kind or another. The ship has opportunities of doing various items of work apart from the routine work, such as surveying.

Since Dr. Deacon and his colleagues came back from the Antarctic *Discovery II* has returned to the south, and she has now completed a new circumpolar cruise. At present she is working on a series of voyages between the ice-edge and Cape Town, studying seasonal variations of the distribution of whales, distribution of temperature and, in fact, distribution of everything we look for out there. She expects to be back in England early next May.

I congratulate Mr. Rayner on the success of the various whale-marking cruises which he has undertaken and also on the good use he made of the opportunity of making a landing on MacRobertson Land and Kemp Land when he was last there in the *William Scoresby*.

Asked by Sir CECIL PEREIRA how a whale was marked, Dr. DEACON replied: A stainless steel dart about 6 inches long is fired from an ordinary 12-bore shoulder gun. The dart has imprinted on it a number and the statement that a reward of £1 will be given to the finder if he returns it to the *Discovery* Committee with particulars of the whale in which it was found. We fire the dart and take as many particulars as possible of the whale into which we fire it, with the date and position. The dart is returned to us with data given by the whalers, and from this we ascertain the lapse of time and the distance which the whale has travelled.

Mr. J. M. WORDIE: I have so many questions to ask that I shall have to postpone most of them till later. Almost every incident seemed to suggest some point of interest, but I will mention two only. I wondered if there were any Emperor penguins at Cape Crozier at the time of Dr. Deacon's visit; and, if they were absent, how this could be explained. A more personal question is to ask whether Clarence Island is a better place to winter on than Elephant Island. We camped on Elephant Island after the wreck of the *Endurance*, and had seen Clarence Island in the distance with curious eyes. You know how the garden of the man next door is always considered better than one's own. Elephant Island was in most respects a particularly bad "garden," but I wonder if Clarence Island was really any better, as we often imagined it must be. What was the shore like at close quarters?

Dr. DEACON: I cannot help Mr. Wordie very much because I only saw Elephant Island in the distance. Certainly Clarence Island is not very good. We had to jump ashore. There were perhaps better landings, but they were threatened by ice overhang. I do not think there is much level land on Clarence Island.

Dr. H. R. MILL, in proposing a vote of thanks to the lecturer and to those who had taken part in the discussion, said: At the beginning of the evening the Chairman said that he had been asked not to say too much about Dr. Deacon

before he gave his lecture. Dr. Deacon has certainly not said much about himself in the course of the lecture, but I have had the advantage of hearing the opinion of those gentlemen of whose ability Dr. Deacon gave such an excellent idea and such well-merited praise, as to his conduct and character as a leader. I can assure you that I would have a great deal that is very good to say of Dr. Deacon if time permitted, especially of the remarkable work he has done on the movements, horizontal and vertical, of the water between the Ice Barrier and the northern limits of the Southern Ocean. The way in which he has developed and worked out that system of convergences and the happy name he has found for them have afforded the utmost delight to those who have followed the gradual progress of oceanography, as I have had the good fortune to do, from the very earliest times of the *Challenger* Reports, right up to and beyond the beginnings of the International Council for the Exploration of the Sea.

I will not at this late hour wait to shower merited praise upon the lecturer or the speakers, or to ask questions, although they have all said much that has aroused in my mind a number of points on which I would like to know more. But one thing I will say, and that is that the hundred years of Antarctic oceanographical work which has elapsed since Sir James Clark Ross left the Thames in 1839 has brought to my mind the feeling that only a poet could do justice to the gradual growth and the magnificent climax of this research. It would make a worthy supplement to Mr. Noyes's 'Torch-Bearers,' in which he touched on the results of the voyage of the *Beagle*, if he could have added a vision of the inner movements of the great sea and of the interplay of science and commerce by which the whales were discovered and exploited, and a fraction of the money profit returned through the *Discovery* Committee to add to knowledge and, we hope, to secure the preservation of the whales.

The CHAIRMAN: It would be an impertinence for me to add anything to Dr. Mill's eloquent summary and his proposal of the vote of thanks. As we have already indicated our approval of the vote of thanks to the lecturer, I will close the meeting without further comment.

# METHODS OF SURVEY IN NORTH EAST LAND

JOHN WRIGHT

THIS paper is a detailed account of the survey of the north coast of North East Land, including the astronomical work, which was carried out by the Oxford University Arctic Expedition, 1935–36. Reconnaissance surveys were also made of the east and south coasts of the island, and several inland traverses were run, in which the distances were determined by a sledge wheel and heights by aneroids. These have all been described in the paper covering the general work of the expedition which appeared in the *Journal* for September and October 1937, and no further mention will be made of them in this paper.

*Triangulation of the north coast of North East Land*

We wished to establish a triangulation accurate enough for future mapping on a scale larger than ours. It seemed unlikely that a scale larger than 1 : 100,000 would ever be required. Therefore we planned that the station farthest east should be fixed relative to Cape Hansteen and Extreme Hook, the stations of origin, with an error of not more than 30 metres, scarcely plottable on 1 : 100,000. Triangulation of this nature would have a permanent value, and from a consideration of the final computations it seems that the required accuracy has been achieved.

By far the most important of the positions previously fixed in North East Land were five of the stations of the Russo-Swedish Arc of Meridian Expedition (1899–1902), which were in the neighbourhood of the western portion of our area. Of these:

Parry Island in the Seven Islands was inaccessible, and the beacon could not be seen.

Walden Island could not be visited until a day at the very end of the expedition, when conditions were unfortunately so bad that no reliable observations could be taken. The beacon was found to have fallen over the edge of the cliff, but its site was identified, and marked by a cairn. This visit was made possible by the courtesy of Dr. Hoel, who took two of us to the island in his ship. During the course of the expedition rays were taken to the highest point of the island, but were not very satisfactory.

At Cape Hansteen a cairn and pole were found standing, and at Extreme Hook there were a large drum and a pole lying on the ground, which were erected on the original site.

Mount Celsius, the fifth of the Russo-Swedish points in the neighbourhood, was found to be invisible from the triangulation stations, and was not used.

Hence we could do no better than to base our triangulation on the side Cape Hansteen–Extreme Hook, though the topography was unfavourable to a good extension eastwards, as the triangulation chart (Fig. 1) shows. In this chart rays which have been observed from both ends are marked as continuous lines, while rays which have been observed from one end only are marked by a continuous line at the end from which observations were taken and by a dotted line approaching the point to which the observations were taken. Com-

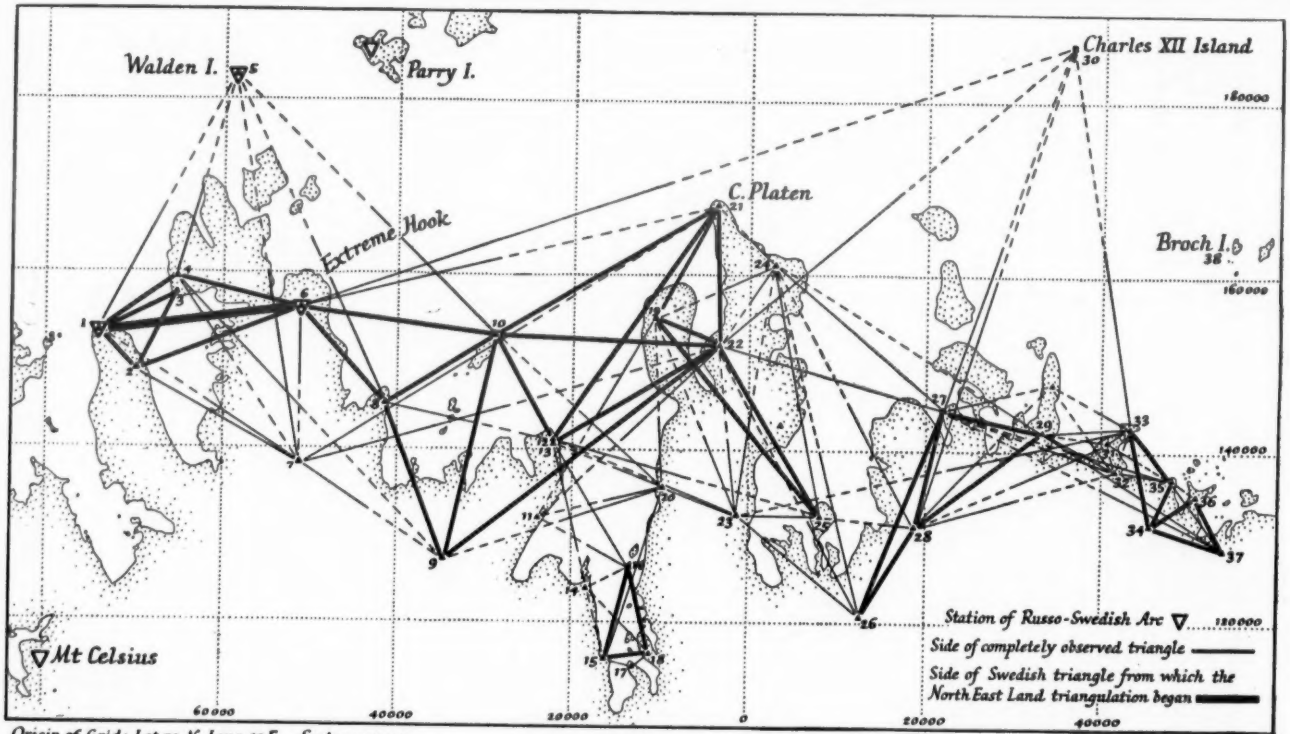

Walden I.
Parry I.
Charles XII Island
C. Platen
Extreme Hook
Broch I.
Mt Celsius
Station of Russo-Swedish Arc
Side of completely observed triangle
Side of Swedish triangle from which the North East Land triangulation began
Origin of Grid: Lat. 79 N. Long. 23 E. Scale 1:750 000

*Fig. 1*

pleted triangles are marked with thick sides, and the side Cape Hansteen–Extreme Hook is drawn extra thick. The triangulation was computed in rectangular coordinates with origin 79° N., 23° E., calculated on a Cassini-Soldner projection, using the R.G.S. tables for the Madrid figure of the earth (1924) (*R.G.S. Technical Series No.* 3).

The positions of the Russo-Swedish stations depend on about twelve latitudes, none north of 79° N., and the longitude of the Swedish station at Treurenburg (79° 56′ N., 17° 02′ E.), on the mean of two determinations by chronometer differences and by occultations. The geodetic coordinates are computed on Bessel's figure of the earth. The astronomical positions of the observatory on Depot Point and its position derived through the geodetic coordinates of Cape Hansteen are as follows:

Depot Point Station: From astr. obs. with 5-inch theod. and W/T signals

80° 23′ 05″ N. 19° 29′ 16″ E. Grid 156,603 m. N. 65,476 W.

By triang. from Cape Hansteen and geodetic pos. Russo-Swedish Arc

80 23 10·1 19 29 54 156,762 65,674

The probable error of our latitude from internal concordance of observations is about 2″, and of our longitude much the same: about 9″ of arc of longitude in these latitudes. The local deviations of the vertical seem to be of the order of 6″ or 7″, judging from the plot of the Russo-Swedish geodetic results.[1] Our observations at Depot Point seem to show that there is no outstanding local attraction there, and that the longitudes of the Russo-Swedish Arc, determined by chronometer differences and occultations, require little correction. In computing the positions of our triangulation stations the initial latitude was that obtained from the Russo-Swedish stations, and the longitude that determined by our own observations at Depot Point.

Three points in this area were fixed by Dr. Rosenbaum during the course of the Swedish-Norwegian expedition led by Professor H. W. Ahlmann in 1931. These points, Cape Platen, Charles XII Island, and Broch Island, were refixed during the 1935–36 expedition.

The initial azimuth of our triangulation was obtained from Cape Hansteen and Extreme Hook, and was carried through the triangulation, corrections of course being made for the larger centring errors, which were caused by the use of satellite stations. No additional determinations of azimuth were made in the field. The fact that on Charles XII Island there was a reference point which was visible from stations all along the north coast reduced the need for additional azimuths, this point acting as a check on the internal consistency of the triangulation, although not on the absolute azimuth.

In the course of about five months' survey thirty-five triangulation and other stations were occupied (see Table I). A discontinuous triangulation, linked by intersected stations, was carried from Cape Hansteen and Extreme Hook eastwards, the chain being eventually completed to the western margin of the Leigh glacier, from which unbroken ice-cliffs run to Cape Leigh Smith. In fifteen triangles, which were not continuous, all three angles were observed, the average triangular error being about 1′. In the other triangles, the third

[1] A. R. Hinks, "A graphical discussion of the figure of the earth," *Geogr. J.* 69 (1927) 557.

TABLE I: TRIANGULATION STATIONS

| *Number* | *Latitude* | *Longitude* | *Height* | *Cairned* |
|---|---|---|---|---|
| 1. Cape Hansteen .. | 80° 20′ 38″.2 N. | 19° 01′ 54″ E. | 277 m. | yes |
| 2. *Hansteen Massif S. Cairn .. .. | 80 18 30·7 | 19 16 40 | 358 | yes |
| 3. Observatory on Depot Point .. | 80 23 10·1 | 19 29 16 | 5 | no |
| 4. *Base Mountain .. | 80 24 17·3 | 19 31 32 | 449 | yes |
| 5. Walden Island .. | 80 37 02·4 | 19 47 27 | — | yes |
| 6. Extreme Hook .. | 80 22 53·6 | 20 15 12 | 394 | yes |
| 7. Mount Toil .. | 80 13 23·2 | 20 17 57 | 630 | yes |
| 8. Cape Lindhagen .. | 80 17 18·3 | 20 47 32 | 212 | yes |
| 9. Ivory Nunatak .. | 80 07 50·5 | 21 11 24 | 458 | yes |
| 10. Scoresby Island .. | 80 21 44·8 | 21 26 59 | 53 | yes |
| 11. *Plancius Valley, pt. 201 .. .. | 80 10 36·8 | 21 44 13 | 201 | yes |
| 12. *Cape Loven Crag | 80 15 22·1 | 21 49 07 | 316 | no |
| 13. Cape Loven, occupied point .. | 80 15 16·7 | 21 49 13 | 343 | no |
| 14. *Cape Bergesen .. | 80 06 22·1 | 22 02 31 | 180 | yes |
| 15. *Cape Lewis .. | 80 02 07·7 | 22 09 29 | 191 | yes |
| 16. *Long Island .. | 80 07 46·6 | 22 17 23 | 19 | no |
| 17. *Kraemer Point .. | 80 01 34·9 | 22 19 20 | 130 | yes |
| 18. Cape Wordie .. | 80 02 25·3 | 22 25 09 | 132 | yes |
| 19. Nordenskiøld Cairn | 80 23 03·6 | 22 24 45 | 461 | yes |
| 20. *The Bluff .. | 80 12 39·2 | 22 28 41 | 162 | yes |
| 21. Cape Platen .. | 80 30 00·5 | 22 47 05 | 318 | yes |
| 22. Mount Cox .. | 80 21 25·5 | 22 48 17 | 546 | no |
| 23. *Barren Hill .. | 80 11 01·1 | 22 55 38 | 343 | yes |
| 24. Mount Goodenough | 80 26 25·4 | 23 08 02 | 529 | no |
| 25. Mount Louise Richard .. | 80 10 56·8 | 23 24 53 | 436 | yes |
| 26. Twin Nunatak .. | 80 04 40·3 | 23 38 59 | 331 | no |
| 27. Mount Conway .. | 80 17 24·1 | 24 10 19 | 334 | yes |
| 28. *High Hill .. | 80 10 19·4 | 23 58 45 | 362 | yes |
| 29. *Comb Mount .. | 80 16 02·4 | 24 45 35 | 287 | no |
| 30. Charles XII Island | 80 39 37·8 | 24 59 31 | — | no |
| 31. *West of Cape Bruun, pt. 240 .. | 80 15 16·9 | 25 08 36 | 240 | no |
| 32. *Glacier Hill .. | 80 13 27·6 | 25 10 57 | 222 | no |
| 33. Cape Bruun .. | 80 16 02·5 | 25 17 15 | 187 | yes |
| 34. *East of Cape Bruun, pt. 218 .. | 80 10 06·9 | 25 22 43 | 218 | yes |
| 35. *East of Cape Bruun, pt. 213 .. | 80 12 54·2 | 25 32 03 | 213 | yes |
| 36. *East of Cape Bruun, pt. 210 .. | 80 11 46·8 | 25 39 19 | 210 | yes |
| 37. *East of Cape Bruun, pt. 200 .. | 80 08 22·5 | 25 48 22 | 200 | yes |
| 38. Broch Island .. | 80 27 19·9 | 25 57 47 | — | no |

* The names of those points which are marked with an asterisk have been chosen for convenience, and are not to be considered official.

point was determined both by intersection and by resection, in no case less than three rays and in several cases six rays being employed in the actual plot.

The triangles were often incomplete because it was impossible to make a reconnaissance, and the forward stations sometimes could not be selected until they were actually visited, owing to a lack of natural marks. In other cases forward rays were taken to a natural mark, such as a distinctive outcrop or boulder, which was not on the summit of the hill. When this station was visited the summit of the hill would naturally be the point occupied, and it would be marked by a cairn. The distance and bearing from it to the original mark would be measured and the original rays corrected to the occupied position. At many of the stations the summit of the hill formed a sufficiently

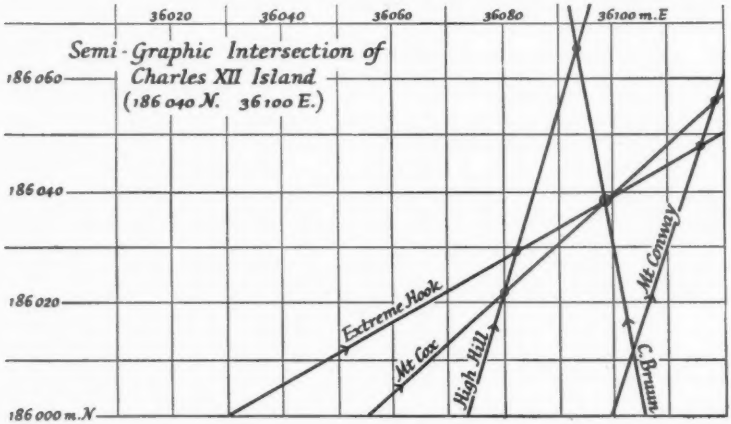



*Fig. 2*

good mark, and no reduction to centre was necessary. It often happened however that the theodolite would be set up a metre or two from the site of the cairn, so that this could be built simultaneously with the taking of observations. In these cases no correction for centring was made.

There is some evidence that we realized something like the accuracy at which we had aimed. Rays were taken to Charles XII Island from stations at various points along the coast. These rays are plotted in Fig. 2, in accordance with the semi-graphic method of computation described in Close's 'Textbook of topographical survey.' It is seen that a perfect intersection is given by the rays from Extreme Hook, Mount Cox, and Cape Bruun, while the rays from High Hill and from Mount Conway give intersections with a maximum eccentricity of 29 metres. This plot was made without any previous adjustment of the triangulation with reference to this point, and it is arguable that it may be taken as giving an idea of the maximum inaccuracy in the triangulation as a whole.

The heights of the stations determined by the Swedish section of the Arc of Meridian Expedition had been measured to a high order of accuracy. Con-

sequently heights were carried through the triangulation from the values given for the Swedish stations, being referred to sea-level only at certain points in the eastern part of the coast. Since the mean tidal range in North East Land was only 1 metre, and since this was the same as the accuracy within which heights were observed, no special determination of mean sea-level was made. A more detailed discussion of the question of the determination of heights, and of the effects of refraction, follows in the next section of this paper.

The speed of work varied considerably, the weather being the most important factor. In general the weather was worse than had been expected. During nearly the whole of May and June 1936 there was almost continuous low cloud, with frequent snow and wind storms, which naturally made survey impossible. The weather during July and August 1936, with an average of three fine days out of four, was considerably better than had been experienced by previous expeditions at that time of the year, and also better than in the corresponding months of the preceding year. During March and April 1936 there were also many days of fine weather, but the low temperature which usually prevailed on clear days rendered observations more difficult.

In all, five months were spent in the field, but naturally only a small proportion of this time was actually spent in surveying, the rest being occupied in travelling to and from the area being mapped, in incidental journeys to fetch depots of food, and in awaiting fine weather. How the speed of work varied is illustrated by the comparison of the nine days from 29 July to 7 August 1936 (in which ten triangulation and intersection stations were occupied and over 150 miles of intricate coast-line surveyed) with the ten days at the end of May 1936, which were spent stormbound in one camp. On an average the proportion of days on which survey was possible was about half of the total number actually spent in the field.

The instruments used for the triangulation were the $3\frac{1}{4}$-inch Watts theodolites (R.G.S. 11, 16), lent by this Society. The latter theodolite was new, but was unfortunately damaged by submersion in a boat accident in the autumn of 1935. Consequently No. 11 theodolite was used for the greater part of the survey of the north coast. Both instruments were more or less identical, and gave good service until the accident occurred to R.G.S. 16. Since the return of the expedition however Messrs. Wild have introduced a new theodolite which might be the ideal instrument for a survey of this nature. Like the Wild Universal theodolite, which this Society lent to the British Graham Land Expedition, it is an eyepiece reading instrument, but it differs from the Universal in being of a lower order of accuracy. Its accuracy would have been adequate for the North East Land survey however, and the advantages of eyepiece reading are considerable in polar conditions, when speed and ease of operation are essential. Furthermore the sites of stations are often poor, on precarious hill-tops or on soft snow, so that the necessity for walking round the instrument should be reduced to a minimum.

The magnification of the $3\frac{1}{4}$-inch theodolite is $\times 12$, which I found usually to be great enough. It should be emphasized however that in this type of survey, where the beacons are often inadequate, as good illumination and magnification as possible should be obtained. The question of weight is also

important. Full recognition of this is of course given in the choice of equipment for sledging journeys, but too often it is forgotten in the case of summer boat journeys. Whatever may be the principal method of travel, there must nearly always be a long walk to the observation point. The theodolite must then be carried, and much time can be saved if its case is suitable for this purpose, and if its weight is the minimum possible.

Certain manufacturers have given a great deal of thought to the design of their cases, but it is obvious that adaptations must be made for the specific conditions which are to be encountered. This has generally to be done by the expedition in question, and the small expenditures involved are amply repaid. It would have been desirable on this occasion to alter the cases in such a way that they could have been mounted easily on a steel frame as used in a Bergen rucksack. We should also have improved the lids of the cases, so as to prevent any drift snow from entering.

The theodolites were supplied with 5-foot telescopic tripods, weighing about 12 lb. each. These were used in the spring survey journey in 1936. Before the subsequent summer journey however I took off both the lower half of the legs and the clamping screws of the extensions. This reduced the weight of the tripod to 6 lb., and the weight of the theodolite, case, carrier, and tripod to 20 lb. On a good site, such as a large flat area of solid rock, one could stand up to use the theodolite, bending down to look through the eyepiece sideways. On bad or precarious sites however most of the work had to be done kneeling. This was a distinct disadvantage, although with an eyepiece reading theodolite observing in this way would have been much easier. It is worth mentioning that on certain stormy days observing with the theodolite using the short legs was possible when the instrument could not have been used with long legs owing to vibration in the wind.

Cairns were the only type of mark used. Where there was either a good natural mark in the shape of a boulder or crag, or where it was impossible to build a cairn because of lack of material, the station was not marked at all. The cairns were of varying size depending on the labour, time, and material available. Usually they were about $1\frac{1}{2}$ metres high and nearly as much in diameter. This size of cairn was visible through our theodolites at a distance of about 25 kilometres, but I have seen one at 35 kilometres, and I have been unable to see another under good conditions at 15 kilometres. Stones could be collected and the cairn built in about half an hour by two people under normal conditions.

It was interesting to find that not one of the beacons erected by the Swedish section of the Russo-Swedish expedition was still standing. This caused some difficulty in the primary stages of connecting the two triangulations. These Swedish beacons had consisted of a large iron drum about 1 metre thick and high, on top of a pole 3 metres high and 10 centimetres thick, held in position by six wire stays. In the beacons which we visited at Extreme Hook and Walden Island the wires had pulled out of the rock, and at the latter place the beacon had fallen over the edge of the cliff. On the other hand the beacons in the form of cairns found at Cape Hansteen, Cape Platen, and Cape Bruun—the last two built by Nordenskiøld in the early seventies of last century (Nordenskiøld, 1879)—were all easily recognized and sometimes used as

sighting marks before we occupied these stations. It seems that in these regions cairns do not usually last very long, because they tend to collapse into a heap of rubble, although they still perform the useful function of acting as identification marks for many years.

*Computation and discussion of the results of the triangulation*

The first step in working out the triangulation was to check the triangles in which three angles had been observed. The next was to plot the whole triangulation graphically in order to eliminate the rays taken to points which had been wrongly identified. These formed under 10 per cent. of the total, which is not by any means an excessive figure under the circumstances. It must be remembered that all forward rays were taken to natural marks, and also that as a rule rays were taken to all stations visible, even if I was uncertain of their correct identification. In such cases a note as to the probable reliability of the sight was made in the angle book.

Working in this way many more rays were taken than was probably strictly necessary. The large numbers of rays however have been of great value. In consequence, every point which has been fixed is either the apex of a completed triangle or the intersection of at least three and sometimes of six rays. In considering the total number of rays, and in discarding those that gave anomalous results, I was largely dependent upon my field book and occasionally my memory for the determining factor of the conditions of observation. The reasons why more weight is given to certain rays are largely dependent upon these circumstances of observation, and it would be difficult for any one lacking experience of the actual observations to discriminate successfully between the rays. Where five or six rays have been taken to a point, a semi-graphic form of solution has usually been employed and the mean position selected by eye.

The question of the degree of accuracy of the farthest east stations of the triangulation has been treated in the preceding section. It should be added here however that all triangles were checked by working both ways round them, as I had no other way of checking the actual calculations. Five-figure logarithms were used, except east of Dove Bay, where the triangle sides scarcely ever exceed 10 kilometres.

The main question with regard to the heights was of course that of refraction, which is notorious in the Arctic for its anomalies. In order to obtain some idea of how this varied under different conditions, I had taken as many sets of reciprocal observations as possible (Table II). In no case were these simultaneous however, and often the two angles of a set were taken under very different conditions. This was unavoidable under the circumstances, but oddly enough the results do not seem to distinguish between these observations and those in which both angles were observed in similar conditions. In Fig. 3 the results are shown graphically. Half the difference of the reciprocal angles of each set is plotted against the distance between the two points at which they were taken. This difference is caused by the earth's curvature, and by the curvature of the rays due to refraction.

This investigation was conducted from a purely practical point of view. Its object was to have some idea of what corrections to apply to elevations and

TABLE II: RECIPROCAL OBSERVATIONS

| *Points* | *Distance* | *Observed correction* | *Calculated correction for curvature only* | *Refraction correction* |
|---|---|---|---|---|
| Hansteen Massif S. Cairn to Cape Hansteen .. .. | 6·08 km. | 110″ | 100″ | +10″ |
| Glacier Hill to Comb Mount .. | 7·48 | 105 | 120 | −15 |
| Mount Cox to Nordenskiøld Cairn .. .. .. .. | 7·93 | 150 | 127 | +23 |
| Cape Bruun to Comb Mount .. | 8·09 | 120 | 128 | −08 |
| Glacier Hill to Comb Mount .. | 9·64 | 180 | 160 | +20 |
| Comb Mount to Cape Bruun .. | 10·2 | 180 | 165 | +15 |
| Comb Mount to Mount Conway | 11·5 | 158 | 184 | −26 |
| High Hill to Mount Conway .. | 13·8 | 210 | 222 | −12 |
| Cape Loven to Scoresby Island | 13·8 | 230 | 222 | +08 |
| Extreme Hook to Cape Lindhagen .. .. .. .. | 14·5 | 210 | 232 | −22 |
| Cape Platen to Nordenskiøld Cairn .. .. .. .. | 14·7 | 220 | 233 | −13 |
| Scoresby Island to Cape Lindhagen .. .. .. .. | 14·9 | 205 | 238 | −33 |
| Mount Cox to Cape Platen .. | 16·0 | 245 | 257 | −12 |
| Cape Loven to Long Island .. | 16·6 | 240 | 266 | −26 |
| Comb Mount to High Hill .. | 18·5 | 260 | 298 | −38 |
| Hansteen Massif S. Cairn to Extreme Hook .. .. | 20·0 | 282 | 332 | −50 |
| Hansteen Massif S. Cairn to Mount Toil .. .. .. | 21·7 | 285 | 350 | −65 |
| Cape Loven to Mount Cox .. | 21·8 | 310 | 352 | −42 |
| Scoresby Island to Extreme Hook .. .. .. .. | 22·4 | 300 | 360 | −60 |
| Twin Nunatak to Mount Conway .. .. .. .. | 25·8 | 340 | 417 | −77 |
| Mount Goodenough to Mount Conway .. .. .. | 25·8 | 335 | 417 | −82 |
| Mount Cox to Mount Conway | 26·9 | 340 | 434 | −94 |
| Scoresby Island to Cape Platen | 29·2 | 405 | 470 | −65 |
| Ivory Nunatak to Mount Cox .. | 39·6 | 565 | 640 | −75 |

depressions, when determining differences of height, in cases where the angle had been observed at one end only. These corrections were also applied to depression angles, by which, as is described in a later section, most of the coast was mapped. It was also desirable to know what uncertainty might be expected in these angles, whether due to observational errors or to anomalies of refraction.

Some simpler aspects of the theory of terrestrial refraction might be considered briefly. We know that, owing to the different refractive indices of the layers of the atmosphere, light does not travel in it in straight lines. In calculating the difference of height between two points, it is necessary to correct the angles at either or both ends, not only for the curvature of the earth, but

also for the curvature of the line of sight. Of course these corrections can be applied directly to the heights, but the question is dealt with more fundamentally if one applies them to the angles.

In order to obtain a simple formula for this correction two major assumptions are usually made (Clark). The first is that the angular correction at each end is the same. This is not necessarily true, particularly in the polar regions, but without this or a similar assumption it would be impossible to begin to calculate the effect of refraction. By this assumption we can take the simple arithmetic mean of two reciprocal angles, when we have them, and it would

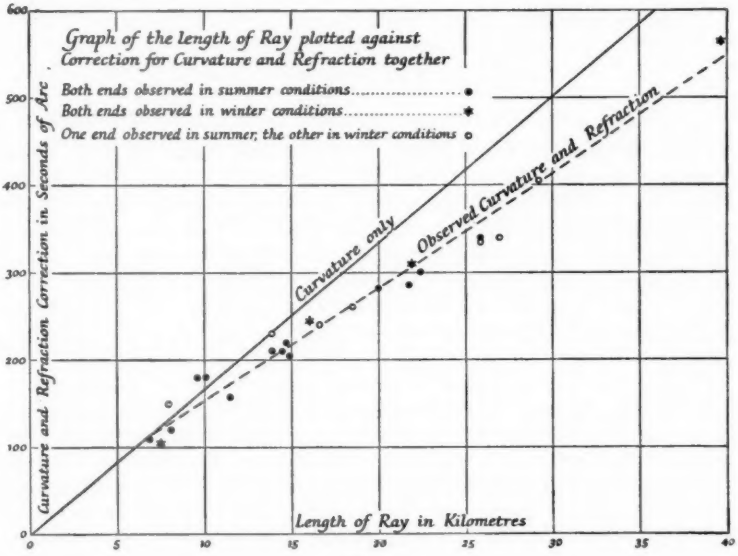



*Fig. 3*

be difficult to arrive at any other solution so simple and comparatively satisfactory.

It seems to me however that there is no need to go on to the second assumption which is generally made. This is that for the same conditions (usually described as place, season, and time of day, or in reality temperature gradient, humidity, and pressure) the curvature of all rays is the same whatever their length. In our case we had reciprocal angles for several rays of different lengths, and thus by using the first assumption could derive figures both for the length of ray and for the amount of the correction. When these are plotted (Fig. 3) we have at once a way of interpolating the corrections for the intermediate lengths of rays, without making any further assumptions. We also obtain an idea of the accuracy of the corrected angles, although we do not know how far the anomalies are due to observational error and how far to anomalies of refraction. From a practical point of view this was comparatively unimportant.

From a consideration of Fig. 3 it is evident that the error of the corrected angles is probably of the order of half a minute. It is larger in one or two cases, but these occur when the rays are short. No corrections were made for the height of theodolite and beacon because these were approximately the same, but at short distances this would cause an appreciable error in the angles. There is some evidence that the mean value of the refraction is not a linear function of the distance. It is impossible therefore to obtain an accurate value of $K$. We may obtain an approximate value however by drawing the straight line which most nearly passes through the plotted points and through the origin.

Using the formula:

$$K = r'' \,.\, R \sin 1''/c,$$

we have $$K = 100\, R \sin 1''/40{,}000$$

or $$K =: 0{\cdot}078, \text{ with a probable error of about } 0{\cdot}005.$$

This compares quite well with J. P. Koch's mean value for sights across land of 0·08 (Koch, 1917). He has obtained much higher values across the sea, but one of his observation points is almost at sea-level, whereas in our case not one was lower than 19 metres, and most were over 200 metres. There is no doubt that in the Arctic, if not elsewhere, the refraction is much greater in the layers of the atmosphere near the earth's surface, which have a very much steeper temperature gradient than those higher up. This is borne out by the fact that one often sees mirages when near the sea, or on a flat plain such as an ice-cap, but one seldom sees them from mountain peaks.

The heights were computed to the nearest metre, and the final results are given to that accuracy. It is difficult to assess the errors in height, particularly as they are variable over the area, but it appears that west of Cape Platen the errors in the given heights are about 1 metre, and east of it about 3 metres. These figures have been reached by a consideration of the differences between values for the same point observed from different directions. The reason for this larger error to the east is that no proper determination of mean sea-level was made east of Rijps Bay, while the points to its west were determined from the heights of Extreme Hook and Cape Hansteen, both of which were accurately measured by the Russo-Swedish expedition referred to above.

A check on the heights farther east however was provided by a carefully measured datum at Long Island (19 metres), and also by the fact that several small lengths of coast were fixed from two different points, whence depression angles were taken. In nearly every case the agreement between the results was less than the plottable error, so that the heights may be safely taken as correct within the above limits.

*Plane-table and topographical surveys*

One of the original intentions of the expedition was to make a detailed map of the whole north coast of North East Land, which should include the accurate contouring of all ice-free land, as well as of the ice-cap in the proximity of the coast. Following this plan, the detailed work until June 1936 was done by plane table. During the bad weather of the spring of that year however it became evident that the mapping of the entire north coast by plane

table would not be possible, and that even the triangulation might not be completed. Speed thus becoming the first essential, plane-tabling was abandoned, and the detail was mapped by a short-base method, supplemented by sketching from photographs.

A detailed map of the whole north coast was thus successfully completed, but only from Dove Bay westwards is it compiled from plane-table surveys. These surveys were made in the course of the boat journey in the summer of 1935, and on the first north coast journey in the spring of 1936. They cover an area representing over two-thirds of the total ice-free land on the north coast. The exact limits of the plane-table surveys can be found by referring to the chart which is inset on the folding map (following p. 280).

On the spring and summer journeys in 1936 the survey parties consisted of two men only. This number seems to be best, unless there is to be some dependence on wild life for food, really dangerous sledging among crevasses, or other scientific work to be accomplished. On the spring journey, when the plane table was still being used, Dunlop Mackenzie and I would separate each day, I going with the theodolite to whatever trig. point was near, while he worked over all the intermediate country, resecting his position from the triangulation. The theodolite and the plane table were regarded as complementary and were practically never used together at the same place. As fast as the triangulation observations were completed, I would compute and plot the points on the plane table. Naturally it frequently happened that, in the final computation of the results, some adjustment of these positions, and also of the plane tabling round them, was necessary.

The work with the theodolite took up a part only of the time required to plane-table a similar area. Thus I would often move camp while Dunlop Mackenzie was engaged in mapping the area towards the new camp site.

The plane tables were three 18-inch square tables lent by this Society. They had collapsible legs which were found to be slightly too light for the conditions experienced. We do not think however that it is necessary to have full-length legs, despite the prevalent windiness, as they are so awkward and heavy to carry. Thin aluminium sheets coated with paper on both sides, supplied by the Ordnance Survey, were used. They were found to be a great improvement on ordinary paper, with all the trouble attendant upon stretching it over the table, which would have been almost impossible under our field conditions. Plain boxwood alidades were used, contouring being by Indian clinometer supplemented by aneroid readings checked frequently at sea-level.

It is questionable how much need there is for the complete mapping by plane table of an area which has been hitherto so roughly mapped as to be unrecognizable, as is usually the case in these regions. For this type of expedition I think it is better to work with the idea of covering as much ground as possible in such a way that the work done is capable of extension to the probable needs of the future. In other words the area should be covered with good ground control in the form of triangulation or astronomical stations, a certain amount of detail being inserted to make the stations recognizable. Of such detail the coast, if it comes within the area, or the edge of any ice-caps are the most important features. The work accomplished is thus of permanent value as control either for a complete aerial survey of the region or for a detailed

survey of some part of it for geological or other purposes. This kind of work in this type of country is in my opinion best and most rapidly accomplished without a plane table, using a theodolite and a camera, which should always be fitted with collimating marks and attached in some way to the theodolite.

The methods of survey were accordingly altered considerably during the expedition. This was both because we were finding out a better technique with increased experience, and because we finally realized that in order to complete the triangulation and the delineation of the actual coast-line, the detailed mapping by plane table would have to be abandoned.

I had had the benefit of Michael Spender's advice in England before we left, but his detailed paper in conjunction with Professor Nørlund (Nørlund and Spender, 1935), on the methods of survey developed in East Greenland, came out while we were away, and therefore was not available. Aided by his advice, but to a certain extent independently, we evolved a method of survey similar in principle, but which differed considerably in detail.

The differences may be expressed by saying that our survey was inferior in quality but easier and quicker in execution, resembling more in method that of the Scoresby Sound Committee's East Greenland Expedition in 1932 (Spender, 1933). The reasons for our inferior accuracy are easy enough to understand. In the first place the personnel available was very much less, for, in all cases except one, our survey parties consisted of only two men. These two had on their hands the whole business of transport, pitching and striking camp, and so forth, in addition to carrying out the actual survey. In Greenland the government surveyors are naturally relieved of all this work, and have also the help of natives in carrying instruments, which can therefore be heavier and more numerous. It would have been impossible for our parties to have carried out at a station the extensive programme described by Nørlund and Spender, because most of our time and energy was spent in getting from one station to the next. This is characteristic of small private expeditions, the aims and man-power of which are necessarily limited.

In addition to this fundamental difference between the two types of expedition, there were also differences in the type of instrument employed and in the character of the landscape. Our instruments have already been described. They were less expensive and lighter than the Wild, but they were also less accurate. Weight considerations forbade the use of auxiliary tripods, subtense bar, or photo-theodolite. The landscape was in our favour however, being much simpler and on a smaller scale than in Greenland, so that we rarely had to climb much higher than 400 metres. Moreover there were seldom enough mountains in sight to cause difficulties of identification, except of the actual mark which had been previously sighted.

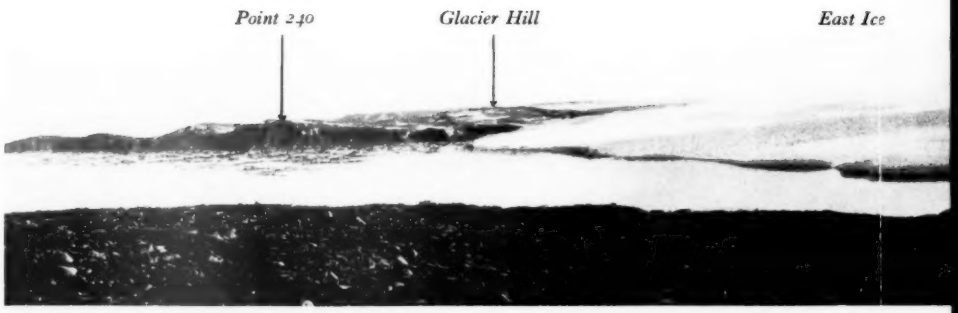
The detailed work with the theodolite consisted of two main parts. These were the mapping of the coast by depression angles and the fixing of points on the ice-cap edge by short-base or ordinary intersection. The first method, although it does not appear in the textbooks, has been used by exploratory surveyors for many years. A brief description will suffice. Points on the coast are fixed by the intersection of the horizontal plane through the base of the trig. point, *i.e.* the sea, and the rays from the trig. point itself. The rays are determined by their azimuths from some known point, and by their angles of

*Cape Hansteen from Depot Point*

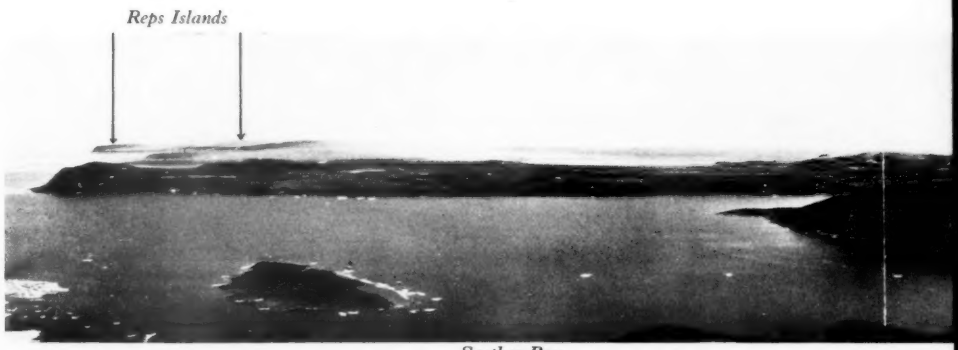
*View towards Mount Toil from the south side of the head of Brandy Bay*

*The Base observatory*

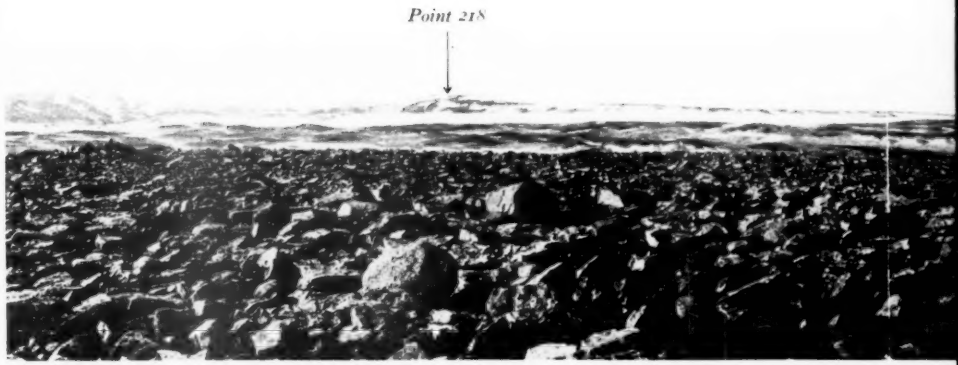
*Using the shortened tripod on Twin Nunatak*




*View south-east from Comb M*

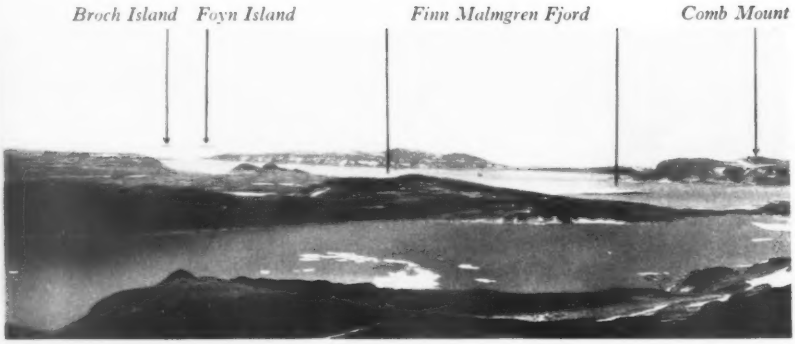



*Looking north-east from Mount*




*View south-west from Point 210, east*

*'omb Mount*




*Mount Conway*

*, east of Cape Bruun*

depression. In other words the height of the trig. point is used as the base of a large range-finder.

The great advantage of this method lies in the fact that only one ray need be taken to each point on the coast, which removes at once any need for the easy identification of that point. Naturally once it has been sighted it is fixed, and can be forgotten. Identification is after all one of the chief difficulties with which the surveyor has to cope.

Using this method we were able to map nearly all the coast except for a few rather intricate little inlets, and the accuracy was generally good, except for the coast of the Reps Islands, which were too far away. The North East Land coast was particularly suited to this method, because of the number of reasonably high steep hills almost directly overlooking the sea.

The mapping of the ice-cap edge was the other main part of the detailed work with the theodolite. This was done partly by intersection from two trig. points, one on each side of Finn Malmgren Fjord, and partly from a short base on the headland west of Rasch Island. The ends of the base were a trig. point and a neighbouring hill, the position of which was found by resection from the triangulation. Just above the edge of the ice-cap was a line of moraines, and the curious shapes that this took made identification of points fairly easy.

Thus what we regarded as the essentials of the landscape, the coast and the edge of the ice-cap, were mapped accurately, but the intervening country could only be indicated approximately. We know that in fact there are many small hills and lakes that do not appear at all on the map east of Dove Bay. It was a choice however of either mapping a small part of this coast completely or mapping the essentials of all of it. We chose to do the latter.

The scale used in plane-tabling was 1 : 250,000, with contours at 100-metre intervals. This plane-tabling covered the ice-free land on the north coast from Lady Franklin Bay to and including the Rijps Peninsula, being supplemented round Rijps Bay with compass surveys by Glen in the summer of 1936. From the Rijps Peninsula eastwards, the detail was mapped entirely by theodolite, using the methods described above. The land round Brandy and Lady Franklin bays was originally mapped on a scale of 1 : 100,000, subsequently being redrawn on 1 : 250,000. The map of the north coast (following p. 280) has been drawn on a scale of 1 : 250,000, and then photographed down to the final scale of 1 : 300,000.

*Winter astronomical observations*

The astronomical work here dealt with consisted of:

1. A series of circum-meridian altitudes of stars for latitude at the Base.
2. Observations of stars east and west for longitude.
3. Two circum-meridian observations of the sun for latitude at the Central ice-cap station.

All the Base observations were made with a 5-inch transit theodolite, made by Cooke, Troughton, and Simms, and lent by the Ordnance Survey. It was an old instrument, and was not as accurate as might have been hoped from its size. Thus from some considerations it might have been better to have used the 3¼-inch Watts theodolite. The lighting for this gave some trouble

however, while the 5-inch instrument was so large that it was simple to fit a lighting system to it which could be easily inspected in case of trouble.

The theodolite was mounted on a wooden pillar frozen to the ground. It was sheltered by an observatory made from cases. This observatory was very rough, but it was equipped with a meridian slit, a sliding roof, electric light, and a telephone, by which the times of observations could be signalled to the Base hut. There they were recorded directly from the main chronometer by the booker. This saved all the trouble experienced by many observers in the polar regions with the effect of the cold on their watches. The chronometer was rated by time signals from Rugby, usually twice a day, and could be relied upon to give G.M.T. correct to a fifth of a second. The recording of the angles was done by the observer himself, as verbal communication over the telephone was difficult and untrustworthy. The altitudes for both the latitude and longitude observations were measured in the usual way and need no further comment, except in so far as they were affected by the difficult conditions.

The low temperature in which observations had to be made naturally caused a certain amount of difficulty. As far as discomfort was concerned however the almost continuous winds played a much greater part, and would have made such a detailed programme impossible without the shelter provided by the observatory. I have since discovered that in calm conditions, and by using thin fur gloves, one can observe in perfect comfort for half an hour at a time in temperatures down to —20° F.

In North East Land apart from actual discomfort the chief difficulties were stiffness in the instruments and the formation of frost on the circles and eyepiece lenses. The former was never so bad as to render the theodolite unusable even in the lowest temperatures experienced (about —15° F.), but it did make it impossible to use the diagonal eyepiece, as it could not be reversed when changing face. This was not serious, since observations were possible without it up to an altitude of 60°. Hoar frost formation could be largely avoided by taking care not to breathe out in the direction of the instrument.

Much difficulty can be saved by having enclosed circles, possessed by most modern instruments, and also by removing the protecting rings round the eyepieces of the telescope and micrometers. The lens can then be easily wiped if it becomes fogged, which happens almost invariably once or twice during the course of observations. It was never cold enough for moisture to condense actually from the eyeball itself, as has been recorded occasionally.

In all, ten stars were observed near the meridian for latitude, giving as a result:

$$\phi\ 80^\circ\ 23'\ 05'' \pm 2'', \text{ N.}$$

Forty-four observations for longitude were made near the prime vertical, of which five were rejected and four given half weight because of large discordances. The final longitude was:

$$\lambda\ 19^\circ\ 29'\ 16'' \pm 9'', \text{ E.}$$

The probable error in $\lambda \cos \phi$ is $\pm 2''$, so that of the adopted position is $3''$, or about 90 metres. The rather large probable error in the longitude (considering the number of observations) is possibly because the rays of the

western stars passed over sea-ice, while those to the east passed over and rather near to the cliff bounding the Base promontory on that side. The computation of these results, together with the conversion of the trig.-point coordinates from rectangulars to geographicals, was carried out by the Scientific Computing Service, Ltd., directed by Dr. Comrie.

The latitude of the Central ice-cap station was determined by two sets of circum-meridian observations of the sun, taken by Croft and Moss in March. They give as a result 80° 05′ 18″ ± 10″, N.; but the uncertainty is larger than this, because of the small altitude of the sun (about 6°) at this time. The longitude was fixed by a ray from Mount Toil which was connected to the main base by triangulation.

The magnetic observations consist of a series of readings of the horizontal

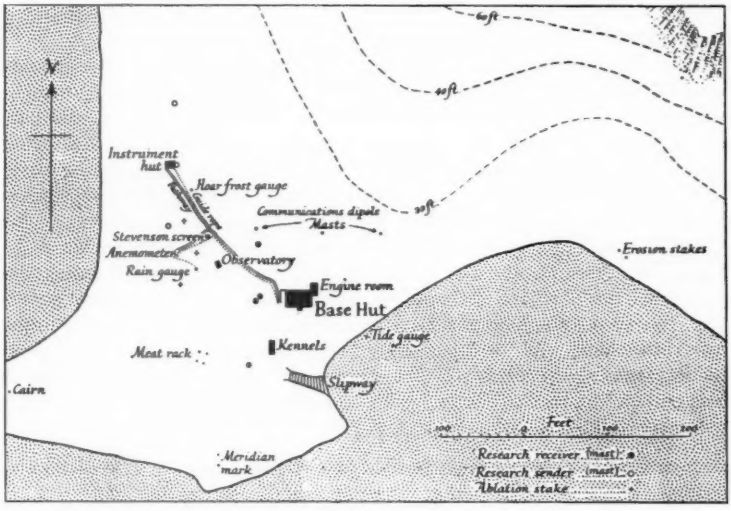



*Fig. 4*

declination, taken at the Base during the winter. The Cooke, Troughton, and Simms theodolite was set in the meridian and readings were made directly off the trough compass with which it was equipped. This compass had a needle about 6 centimetres long, the ends of which projected over scales divided in half degrees. From these scales readings were made directly, being estimated to the nearest 10′ of arc. During the observations the theodolite was never moved, and it is hoped that the results are fairly accurate. It must be recorded however that they do not agree perfectly with those obtained by Hamilton (Hamilton and Whatman, 1938) with a continuously recording magnetograph.

Readings were made every two hours in the twenty-four, on four days in January and February. The main result is 02° 15′ east of north with a mean daily variation of amplitude approximately 01° 10′. The extreme range was from 1° west of north to 7° east of north.

At Fort Rae in 1933 (Stagg, J. M., 1937), for the corresponding months the

means of the daily variations were 26·5′ and 25·5′, or one-third of that obtained in North East Land.

Unfortunately the observatory at the main base was removed during the spring while I was away, and the exact site left unmarked. However Fig. 4 is a map of the Base promontory, showing the relation of the observatory to the Base hut, which is now the property of the Norwegian Government, and therefore will presumably be protected from the depredations of sealing-ships. Its position relative to the south-west corner of the main hut is north 21 metres, west 23 metres. It is hoped that, with the aid of the map, the site of the observatory may easily be found, as many of the objects marked on the map should be identifiable for a long time to come. Some of them, such as the wireless masts, were removed when the expedition left North East Land in 1936.

*Conclusion*

I should like to take this opportunity of expressing my thanks to all those who helped with the planning and execution of the survey, before the expedition, during its course, and after its return. Amongst these I would particularly like to thank Mr. Michael Spender and Captain H. Carington Smith, R.E., both of whom gave me the benefit of their experience in Arctic survey; Dr. A. Hoel, Baron De Geer, Professor Ahlmann, and Dr. Rosenbaum, who put at my disposal the information previously available; and Sir Gerald Lenox-Conyngham, Professor Debenham, Colonel Craster, Mr. A. R. Hinks, Professor Mason, Dr. K. S. Sandford, and Mr. J. M. Wordie, who gave much useful advice. I should also like to thank Mr. Glen for giving me a free hand in the planning of the survey, for the support which he gave to the work in the field, and for the untiring help and encouragement he has given me in preparing this paper. The final form of the paper owes a great deal to him and to Mr. Hinks. Lastly I wish to acknowledge my debt to the other members of the expedition for a great part of the results obtained.

*Note on the map published in the* Journal *for September 1937. This map was also published in the official account of the expedition: 'Under the Pole Star'*

This has been compiled from a large number of sources. The north coast has been copied from the map published with this paper, and so no further acknowledgments are necessary. The east coast is from a traverse by Glen and Croft, tied down to Isis Point (fixed by Binney in 1924), and also as far as possible to Ahlmann's position on Great Island, and Worsley's fix for Ice Point. The former of these could not be positively identified, and the latter may well have moved, but the amount of adjustment needed was not very great, and the position of this traverse should be accurate to about a mile. Within itself the accuracy is considerably higher. No fix was possible to the party conducting this survey, owing to the unfortunate breakdown of their time-signal set.

The western half of the south coast is from a theodolite survey by the same party, resected roughly from Thumb Point and Cape Torell. The latter was not identified with certainty owing to disappearance of the beacon. The eastern half of the south coast, between East Ulve Bay and Ice Point, is unmapped.

Wahlenberg Bay is from the survey of the 1924 Oxford expedition. The west coast is from De Geer ((1899–1902) Russo-Swedish expedition). The interior is taken from Professor Ahlmann's map with corrections from our own observations, usually made with some sort of instrumental methods.

*Note on the names on the map of the north coast published with this paper*

The following names have been approved by the Norges Svalbard og Ishavs Undersøkelser:

Reindeer Bay, Ivory Nunatak, Kulling Nunatak, de Geer Ice, Ahlmann Ice, Nordenskiøld Cairn, Mount Goodenough, Mount Cox, Mount Binney, Mount Louise Richard, Saether Bay, Mount Conway, Alpini Island, Cape Wordie, and Rasch Island.

The following names have been used on the map or in the text for convenience, but have not received official approval:

Cape Bergesen, Base Mountain, Long Island, Windy Bay, Barren Hill, Twin Nunatak, High Hill, Comb Mount, Glacier Hill, Cape Lewis, Kraemar Point, and the Bluff.

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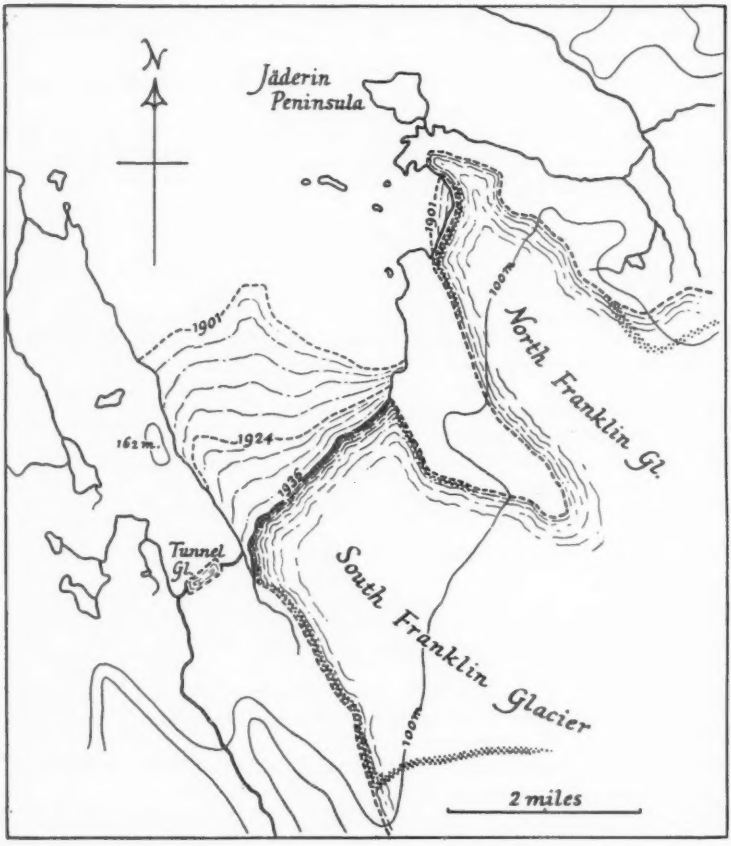
# THE RETREAT OF THE FRANKLIN GLACIER, NORTH EAST LAND

R. MOSS AND A. R. GLEN

THE surveys accomplished by the Swedish section of the Russo-Swedish Arc of Meridian Expedition, 1899–1902, and by the Oxford University Arctic Expeditions of 1924 and 1935–36, afford interesting data for determin-




*Sketch-map showing the retreat of the Franklin glacier*

ing the retreat of the main branch of the Franklin glacier during the last thirty-five years.

The Franklin glacier is the most important western outflow from the West Ice of North East Land. The accumulation area of the West Ice is limited to

*Face of the Franklin glacier seen from the Tunnel glacier (May 1936)*

*Terminal moraines of the Franklin glacier near Hill 162 m., showing approximate frontal position of the glacier in 1924 (photographed May 1936)*

*Aerial photograph of the Franklin glacier in summer 1924. The Tunnel glacier lies in the right background*

the inverted T-shaped framework of high ground, which forms an east-to-west ridge to the north of Wahlenberg Bay, with an extension of this ridge running north to culminate in the Sabine massif. The eastern part of the area has its main outflow into Rijps Bay, while the Franklin glacier forms the main western outflow. The terminal conditions of the Franklin glacier are therefore important because of the information they offer as to the state of glaciation of the West Ice.

The sketch-map opposite shows the position of the seaward face of the glacier in 1901, in 1924, and in 1936. The 1901 position was determined by De Geer, who had a photogrammetric station at the point 85 metres on the Jäderin Peninsula, and another about $2\frac{1}{2}$ miles to the north-west of the glacier face, on the eastern shore of Lady Franklin Bay. These two stations should give reliable intersections for the salient points of the glacier face, and these may therefore be considered to have been fixed with some precision. Beyond doubt the glacier at that time must have met the western shore at a point considerably to the north of the prominent isolated hill, 162 metres high.

The 1936 position is taken from a plane-table survey of the neighbourhood, which was based on the trig. points fixed by De Geer, and by the 1935–36 expedition. It is therefore of a similar order of accuracy to the 1901 survey. The 1936 survey reveals an interesting feature, to which the name of "Tunnel glacier" has been given. This consisted of an apparently immobile sheet of old and dirty ice, about 60 feet thick and 500 yards long, which covered a river gorge running partly through rock and partly through moraine.

The 1924 position is plotted from aerial photographs taken by Ellis and Tymms. Its accuracy is perhaps not as great as that of the other two positions. It proves without doubt however that the seaward face of the glacier was at that time well to the north of the Tunnel glacier, which, together with the partly snow-filled water-courses converging upon it, is clearly shown in the aerial photographs.

Thus it is certain that the main branch of the Franklin glacier has retreated more than $1\frac{3}{4}$ miles since 1901, and it appears that the mean rate of retreat, measured along the medial line, has been approximately the same during the two periods of observation. It would be most valuable if further observations could be made, during the next few years, to discover whether this rate is maintained.

# THE CANADIAN SHIELD AND ITS GEOGRAPHIC EFFECTS

E. L. BRUCE

THE Canadian Shield is the area of rocks of Pre-Cambrian age which occupies the greater part of central and eastern Canada, extending southwards into the United States west and south of Lake Superior and east of Lake Ontario. Within the Shield is the outlying area of Palaeozoic rocks fringing the southern part of Hudson Bay and James Bay. Probably the greater part of the rock floor beneath Hudson Bay also consists of Palaeozoic formations. To the north the ancient rocks of the Shield disappear beneath the Arctic Ocean, but Palaeozoic rocks are found on most of the islands of the northern archipelago. Eastwards the Pre-Cambrian is covered by the early Palaeozoic of the St. Lawrence valley. For the first 50 miles of its course however the St. Lawrence flows through a tongue of the older rocks, the Frontenac axis, which connects the Adirondack region of New York State with the main mass. West of this narrow zone Palaeozoic rocks again appear as the Shield boundary and extend round the southern and western side to northern Saskatchewan, where they disappear beneath overlapping Cretaceous rocks, which for a considerable distance rest directly upon Pre-Cambrian formations.

Most of the rocks of the Canadian Shield are highly metamorphosed and much disturbed. The structure is that of rocks in mountainous areas, but the mountains that once existed have been removed by erosion so that in few parts of the Shield are there elevations rising more than a few hundred feet above the valleys. Locally the surface is rough or even rugged, but considered in a large way uniformity of the land surface is the outstanding feature of the topography.

In northern Manitoba and northern Saskatchewan the boundary of the Shield is most irregular, since erosion has left salients of younger rocks extending outwards from the main mass, and outliers of them remain isolated at considerable distances from the margin. In many places the Palaeozoic or Cretaceous rocks rise in low escarpments fronting towards the irregular mammillated surface of the Pre-Cambrian. Along the Ottawa river, on the contrary, the older rocks form highlands which are due in some places to downwarp towards the south and in others to faults. Fault relations also exist along the St. Lawrence river so that the Pre-Cambrian rocks north-west of the river form an upland which is rather strikingly in contrast with the level plain to the south-east. The bevelled surface of the Canadian Shield is apparently warped and tilted. West and south-west of Hudson Bay the elevations are rarely more than a few hundred feet above sea-level, and the whole region slopes gently towards Hudson Bay, under which the slope continues at a gentle gradient, so that the bay is shallow for a considerable distance from the shore. In contrast with this, the Labrador plateau rises abruptly on all sides, and in the Torngat mountains of northern Labrador reaches elevations of 5000–6000 feet above sea-level. The highest part of the

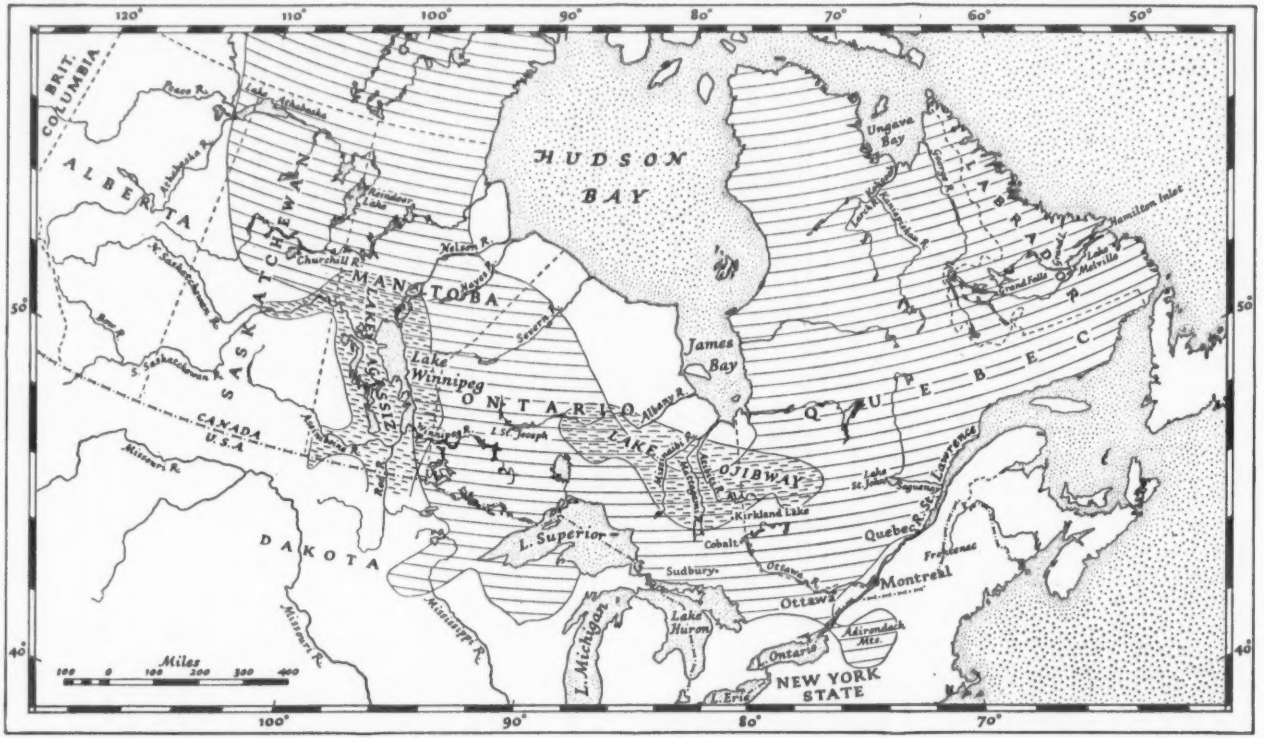
plateau is near the Atlantic coast, and the mountains are carved in the edge of the slightly tilted, peneplained surface, into which deep valleys have been incised. Some of the residual masses have been entirely separated from the main plateau and form isolated mountains. In other places the valleys rise gently inland for long distances; seaward they form narrow, deep, steep-sided inlets. One of the most striking of these is Hamilton Inlet with its continuation, Lake Melville, and the tributary waterways of the same fiord type—Grand Lake, Double Mer, and the Back Way.

The shores of Hamilton Inlet rise steeply several hundred feet above water-level. The south shore of Lake Melville is bold and rocky, the Mealy mountains rising to heights of 3000–3800 feet at distances of less than 10 miles to the south-east. Along the north shore however a lowland underlaid by Palaeozoic sandstone extends inland a few miles. Hamilton Inlet and Lake Melville are navigable for sea-going vessels for 150 miles from the open sea, and Lake Melville has a maximum depth of nearly 1000 feet below sea-level. In contrast with this the outlet which connects it to the ocean has depths of only 9–30 fathoms.[1]

Most of the fiords or rias are walled on both sides by the ancient rocks of the plateau and, commonly, minor depressions join the main one as hanging valleys. Rugged islands, some of them rising steeply to heights of more than 2000 feet, fringe the shore in places and are separated from it and from one another by narrow channels, most of which are deep enough to be used by fishing-boats sailing along the coast.[2] Apparently, along the Atlantic coast of Labrador and along the north shore of the St. Lawrence river, subsequent to the deep incision of the valleys both by normal erosion and by valley glaciers, there was a decided sinking of the land surface so that the sea occupied the lower parts of the steep-sided valleys for considerable distances inland. In late Pleistocene time the coast was elevated about 300 feet above the level of maximum depression.

The existence of a surface, bevelling indiscriminately rocks of various degrees of resistance, is difficult to explain except as a result of nearly complete peneplaination. That it was developed prior to Palaeozoic times is clearly shown by those portions recently exposed, the mammillated surfaces of which are very similar to those which suffered Pleistocene glaciation. Evidently also the tilting of the surface of the Labrador plateau and the incision of the trench-like valleys occurred prior to the deposition of the Cambrian sandstone that is found in a few places. Although the Pre-Cambrian rocks beneath the Palaeozoic are comparatively fresh, there are places where weathering had reached to some depth prior to burial of the ancient rocks beneath younger sediments. As these were stripped away by erosion, the renewed exposure of the old surface permitted further etching of the old complex and the formation of pockets of soil and of rock debris wherever easily disintegrated rocks are present. Pleistocene glaciation removed some of this material and, as it scoured off comparatively little solid rock, it exaggerated the former relief and disorganized the previously existing drainage systems. The result therefore is a surface which in a large way retains the monotony

[1] E. M. Kindle, Mem. 141, Geol. Survey of Canada, pp. 13, 14.
[2] A. P. Coleman, Mem. 124, Geol. Survey of Canada, p. 7.




*The Canadian Shield and the approximate position of the post glacial lakes. The area covered by the Shield is shown by horizontal ruling*

of the peneplain, but in detail is excessively rugged, with hard massive rocks, such as granite, forming low, domed uplands, and gneisses or resistant beds of metamorphosed sediments producing narrow, steep-sided ridges between elongated lakes or swampy areas, where weathered material from more easily attacked rocks was scooped out by the ice-sheet.

Wherever the ice was stagnant for any considerable time during the retreat of the continental glaciers, terminal moraine deposits of sand and gravel cover the irregular rock surface, give to the topography a hummocky and irregular character, and further disorganize the drainage by damming old stream channels and producing lakes or forcing the streams into new courses.

Retreat of the ice-sheet northwards down a gently northwards-sloping land surface resulted in the formation of glacial lakes. The northern shore of each lake was the ice-barrier, which blocked the natural drainage system of the area; the southern shore was determined by the position of any low point by which drainage to the south might be accomplished. Various old beaches can be recognized for most of these post-glacial lakes, each beach marking a stage during which the lake maintained a definite level. As the ice retreated the southern margins migrated northwards to lower and lower levels, until finally some outlet was opened at a level sufficiently low to drain the lake, or until the present lake systems became established. Some of the post-glacial lakes persisted for long periods, and in them were laid down thick deposits of regularly stratified clays. These mask completely the irregularities of the rock surface and produce the great level areas of the clay belts. Glacial Lake Agassiz occupied parts of the provinces of Saskatchewan, Manitoba, and Ontario in Canada and parts of the States of Dakota and Minnesota. The east part of this lake overlapped the edge of the Canadian Shield. Its deposits cover an area of approximately 100,000 square miles. Lake Algonquin, at its maximum size, occupied the present basins of Lake Superior, Lake Huron, and Lake Michigan, and extended beyond the areas now occupied by them. The highest beaches of the glacial lake are 435 feet above the present level of Lake Huron at the north and 232 feet above it at the outlet of Lake Michigan.[1] Thus clays deposited in it mantle the rocks for a considerable distance above Lake Huron and Lake Superior and extend as level areas some distance inland along the larger river valleys. The outlines of the last of the great glacial lakes, Lake Ojibway, are not yet entirely known. Its former bed now forms the clay belt of northern Ontario and northern Quebec.

The pre-glacial drainage system was disorganized in various ways by these events. The glaciers stripped off the soil, left a mammillated rock surface, and destroyed to a great extent the graded character that the rivers on the peneplained surface must have had. In places deposits of glacial debris obliterated former river systems. In those parts of the Canadian Shield which were covered by post-glacial lakes, any river valleys not destroyed by either of these other processes were completely filled with clay.

Where not covered by clay the surface left exposed by the ice retreat is characterized by innumerable lakes of all sizes. Some of these occupy rock basins; others are retained in part by glacial debris. To some extent however their form and distribution are controlled by the patterns etched in

[1] F. Leverett, Summ. Rept., Geol. Survey of Canada, 1912, p. 271.



*The Canadian Shield and the approximate position of the post glacial lakes. The area covered by the Shield is shown by horizontal ruling*

the rock floor by pre-glacial weathering. In schistose or gneissic rocks the lakes are elongated or have long narrow bays that lie parallel to the rock structure. Where the rocks are massive the lake outlines are extremely irregular, the development of bays and arms depending upon some slight depression in the rock basin or upon glacial damming. The lakes range in size from mere ponds up to immense bodies of water such as Lake Superior on the Shield margin, and Reindeer Lake or Lake Athabasca lying wholly within its boundaries. The grouping of large lakes along the contact between the Pre-Cambrian rocks and the younger formations is a striking feature noted by Suess.[1] The large glint lakes bordering the Canadian Shield are Huron, Superior, Winnipeg, Athabasca, Great Slave, and Great Bear.

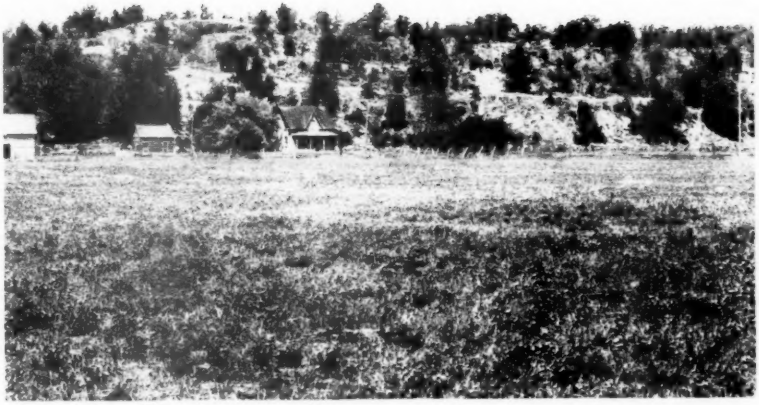
In the areas covered with clay the rivers have definite valleys, and some in the clay belts have reached a mature stage in parts of their courses. Where consolidated rocks are abundantly exposed the rivers have, as yet, not been able to excavate well-defined channels, and the river systems consist simply of chains of lakes, connected by short and turbulent stretches where the water from a higher basin spills over the lowest part of the rim and follows whatever depression is available down to the next lower basin. Wherever a well-defined valley occurs, it is the result of a chance occupation for a short distance of a pre-glacial valley, or the development of a more mature type of stream in a clay-filled depression.

The contrast between the rivers of the Shield and those flowing over areas of younger rocks is well shown by comparison of some of the larger rivers. Churchill river rises near the western margin of the Pre-Cambrian area and flows east to Hudson Bay. For almost its entire length it consists of a series of lake expansions, each draining to the next lower by a comparatively short river stretch, commonly interrupted by numerous rapids and falls. It has a drainage basin of over 100,000 square miles, yet steam boats of small size can ascend it for a distance of only 7 miles from Hudson Bay.

Nelson river, some tributaries of which rise in the western Cordillera, is much more diverse in character. From the headwaters of its longest tributary, the Bow river, to Hudson Bay the length of the Nelson system is 1660 miles; the area of its drainage basin is 370,800 square miles. Several of the western tributaries unite to form the Saskatchewan river, which empties into the northern end of Lake Winnipeg. From the north-eastern angle of the lake the water, augmented by that brought into the south end of the lake by the Winnipeg, Red, and Assiniboine rivers, flows out as the Nelson river. The Saskatchewan for its entire course, and the Nelson for the lower 90 miles, flow through Palaeozoic and younger rocks. From Lake Winnipeg for 270 miles the Nelson crosses the Canadian Shield. The Saskatchewan is navigable for river steamers for considerable distances, and the Nelson can be ascended by boats of fair size for a distance of about 60 miles from Hudson Bay. The part of its course within the Canadian Shield consists mainly of lake expansions, and is navigable only by canoes or light boats that can be carried round the rapids and falls in the river links that connect the lakes.

Of the larger rivers that flow northwards to James Bay and the southern part of Hudson Bay, the Hayes river is very similar in character to the Nelson.

[1] E. Suess, 'The face of the earth,' pp. 65, 66.



*Escarpment of Pre-Cambrian rocks standing above Palaeozoic near Ottawa*

*Royal Canadian Air Force photograph*

*Labrador coast looking east over Port Burwell to McLellan Strait*

*Royal Canadian Air Force photograph*

*Northern shore of Lake Superior near Nipigon, showing mesa topography produced by diabase sills*

*Granite hills in northern Manitoba*

It rises in lakes north-east of Lake Winnipeg, and the upper part consists of connected lake expansions. For a distance of over 100 miles from its mouth it is unobstructed by rapids. For much of this distance it flows over Palaeozoic rocks, but the mature character of the river is due chiefly to the fact that the consolidated rocks are clay-mantled. The Albany river rises in Lake St. Joseph and flows north-easterly to James Bay. The Moose river, also emptying into James Bay, is formed by the junction of three large rivers, the Missinaibi, Mattagami, and Abitibi, which drain a large area in northern Ontario. The Albany and the tributaries of the Moose cross the old bed of Lake Ojibway; the lower parts of the Albany and the Moose flow over Palaeozoic rocks. Thus only in the headwater regions of these systems are they characterized by lake expansions. Rapids occur where their channels have cut down through the clays to boulder ridges of the underlying glacial drift, or to consolidated rock. In many places tributaries of the Moose flow in valleys 75–100 feet below the general level and have not yet cut down to the rock floor.

The larger rivers flowing down from the Labrador plateau to the east side of Hudson Bay enter it in narrow gorges cut to considerable depths below the level of the upland. Beyond 50 miles from the coast however the streams are only slightly below the general level of the country.[1] Some of the large rivers of Labrador which flow northwards have well-defined valleys, and are broken only here and there by rapids. Thus the George river, flowing into Ungava Bay, is swift but fairly well graded. At places there are gorges and rapids, but mostly the valley is wide and open.

The Koksoak river and its tributaries the Kaniapiskau and Larch have much the same characteristics. Low describes the Koksoak as follows: "From Lake Kaniapiskau (lat. 54°) to the head of the gorge (about lat. 55°) the river wanders about almost on the surface of the country, spreading out into lakes, where the surface is flat, and contracting into narrow rapids when it passes between low ridges. . . . The absence of a distinct valley and the presence of rapids over boulder-clay show that the river is here flowing in a modern course, and does not follow its pre-glacial valley, which is filled with glacial debris. At the gorge, this changes, and the river passes down from the general level into a deep distinct river valley, probably of very ancient origin. The river follows this old valley from the gorge to its mouth. The valley is, of course, not of constant depth, but descends in a series of steps, with the gradual slope of the surrounding country." [2]

The large rivers of the Labrador plateau flowing east and south enter the Atlantic Ocean or the St. Lawrence river in valleys which extend from 100 to 300 miles inland at 500–1000 feet below the level of the country. At the inland extremity of these deep valleys the rivers descend into them from the lakes of the interior in successions of rapids and falls. The lower ends of these valleys are drowned, so that many of the rivers enter the heads of rias which extend many miles inland from the sea between high steep walls, notched here and there by the hanging valleys of tributary streams, or joined at grade by a converging ria carrying in the waters of a river of some size.[3]

[1] A. P. Low, *Ann. Rept. Geol. Survey of Canada* 9 (1896) 10L.
[2] A. P. Low, "Labrador Peninsula," *Ann. Rept. Geol. Survey of Canada* 8 (1895) 110L.
[3] A. P. Coleman, Mem. 124, Geol. Survey of Canada, p. 7.

The Hamilton river is the largest river entering the Atlantic from Labrador. It is estimated to have about the same volume of water as the Ottawa river. "Owing to the great difference in physical character between the upper and lower portions, the Hamilton river is naturally divided into two parts at the Grand Falls some 250 miles from its mouth. The lower part occupies a distinct valley, with the present river-level 500 to 600 feet below the general level of the surrounding country. The valley varies in width from 100 yards to more than two miles, and the river flows down it, between banks of drift, with a strong current broken by rapids in several places, especially along the upper stretches, but only in one place does it fall over an obstruction of rock." [1] Into the upper end of this deep valley the main branch of the Hamilton river comes down from a small lake expansion which is almost at the plateau level in "one of the greatest and wildest descents of any river in Eastern America." In twelve miles the total fall is 760 feet, which includes a sheer fall of 302 feet.[2] Above the Grand Falls there is no distinct valley; the river consists of an alternation of short rapids and long lake expansions.

The Saguenay river, which drains Lake St. John, enters the St. Lawrence river between walls which rise almost vertically 1000 feet above water-level. For 90 miles from its mouth the river is at sea-level, and in places the bottom of the gorge is several hundred feet below the average tide-level.[3]

The effect of the physical character of the Canadian Shield upon human geography is very clearly discernible. As climate varies from one in which for at least four months temperatures below freezing may be expected to one in which the conditions are Arctic, the primitive inhabitants did not develop permanent communities, but depended very largely upon hunting and fishing for their sustenance. In the far north both Indians and Eskimo followed the migrations of the barren ground cariboo. On the plains the immense herds of American buffalo (bison) supplied the Indians with food and material for clothing and tents. In the wooded areas of the Hudson Bay basin moose, deer, smaller animals, and fish were the chief food, together with berries, wild rice, and, in the southern part of the Shield area, potatoes and maize cultivated in a primitive fashion.

Such conditions resulted in isolated groups, most of the individuals of each of which were blood relations. Each group hunted, trapped, and fished in a certain well-recognized but vaguely defined area and, excepting in the farthest south regions, there was no very definite organization into larger units.

The coming of the great French and English trading companies modified to some extent the living conditions of the Indians, since clothing, fire-arms, and new kinds of foods were supplied in return for furs. The French traders drew to Montreal and Quebec the tribes of the Ottawa valley and the basin of the St. Lawrence river. The English organization, the Hudson's Bay Company, at first established posts on the shores of that great inland sea, and to them the Indians came from long distances south and west. After the cession of Canada to Great Britain, Canadian traders penetrated into the country

[1] A. P. Low, *Ann. Rept. Geol. Survey of Canada* 8 (1895) 129L.
[2] A. P. Low, *ibid.*, p. 140L.
[3] J. A. Dresser, Mem. 92, Geol. Survey of Canada.

formerly tributary to the Hudson's Bay Company's posts, and the natives no longer needed to make the long and arduous journey down the rivers to the bay. To meet this competition the Hudson's Bay Company was forced to establish inland trading-posts. The first of these was Cumberland House, founded in 1776 just north of the Saskatchewan river. Gradually a network of these posts was extended over the greater part of the drainage basin of Hudson Bay. For a time there was intense rivalry between the Hudson's Bay Company and those trading from Canada, but finally amalgamation was effected, and for many years the trade of the greater part of the Canadian Shield flowed through the trading-posts on Hudson Bay.

No doubt the dominance of the Hudson's Bay Company was in part due to the wars, first between France and England, and later between England and the American colonies, which altered radically the trade routes west of Lake Superior. But to a much greater degree it was due to the character of the country and of the trade. The fur-trading companies simply supplied a market for the furs of the Indians, for which they returned certain goods, especially fire-arms, traps, etc., by which the quantity of furs taken was enormously increased. They made little or no change in the habits and lives of the people, excepting that each trading-post became the centre of the life of the area it served, and the natives came to depend upon the companies for clothing and many articles of food first brought to them by the white man. The tepee might be made of canvas rather than of skins, but that meant no fundamental difference. The canoe still remained the means of transport. Somewhat larger ones were used by the Hudson's Bay Company for its fur brigades, and the "six fathom" canoe came to be the symbol of the company's prestige and the unit of its transportation system. But even this was a rather small freight craft, handled by man-power over the portages, and requiring no change in the training and customs of those who manned it. The rivers flowing to Hudson Bay were admirably suited to this method of transportation, since men accustomed to canoes from infancy, and familiar with the rivers and their navigation, could take supplies hundreds of miles from the main posts on the bay and bring back, in the same canoes, the valuable return cargo of furs. On the other hand, traders from the St. Lawrence were handicapped by the difficulty that canoes, suitable for travel on the rivers of the Canadian Shield, were much too small for safe or uninterrupted travel on the Great Lakes of the St. Lawrence system. Larger boats were necessary for that part of the journey, and cargoes had to be transhipped several times. This required methods to which the natives were not accustomed, resulting in lower efficiency and increased loss of and damage to goods. Hence it came about that the commerce of a great part of the Canadian Shield changed little in kind, or in methods of transportation, until after the transfer of the great Hudson Bay territory to the Dominion of Canada in 1868.

In the states south and west of Lake Superior deposits of iron ore of major importance were discovered in 1849; copper production began a few years earlier. No mineral occurrences of the same order were found north of Lake Superior. On the Canadian side the valley of the Ottawa river early began to supply timber, which was rafted down to mills at Ottawa, but for the major part of the Pre-Cambrian area in Canada the chief product, until compara-

tively recent times, was furs. Though the fur trade was important, its total value compared with the area from which it was drawn was insignificant, and when plans were considered for the entrance of British Columbia into political union with the Dominion of Canada, the great area of rocky country, extending from Lake Huron and Lake Superior northwards, was still considered to be uninviting and unprofitable, a barrier between east and west.

Gradually however extension of the lumber industry and the construction of lines of railway to connect eastern and western Canada led to small permanent settlements within the Shield and the discovery of mineral deposits of importance. The building of the Canadian Pacific railway led to the discovery of nickel and copper at Sudbury. The Temiskaming and Northern Ontario railway was built to encourage settlement of part of the clay belt in the basin of post-glacial Lake Ojibway. Its construction led to the finding of silver at Cobalt and, as a direct result, to the finding of gold at Porcupine, Kirkland Lake, and many other places, and of copper at Noranda.

Successful exploitation of mineral resources of considerable variety, occurring over a wide area, has disproved the idea of the barrenness of these ancient rocks. Opinion has now swung to the opposite extreme, which is probably as far from the truth, that they are storehouses of mineral wealth of exceptional richness. Search for ore deposits has been carried far beyond the zones served by the railways. The old means of travel, by canoe or by dog-team, have been utilized, but to an ever-increasing extent the aeroplane has been brought into service, and areas formerly so difficult of access that they were not considered as possible localities for prospecting activity are now being examined with as much ease as any other part of the Shield. Notably in the vicinity of Great Bear Lake, in the far north-west, silver and radium deposits are being developed and concentrates are being transported by air.

The southern part of the Canadian Shield is now producing a very considerable amount of wealth, and the mining centres support towns of some size. Railways, built to develop the agricultural resources, now depend for a very large portion of their revenue upon the output of the mines and the goods shipped in to support mining communities. These centres also supply local markets for farm produce, and in that way the mining industry is accelerating agricultural development. Thus that area which was formerly considered as a barrier between the eastern and western parts of the Dominion of Canada has become a link between them, absorbing from the west some of its wheat and from the south its manufactured goods.

The sudden increase in the mineral output of this great region is due to various factors. Transportation, long delayed because of the character of much of the Canadian Shield, has now reached the southern parts of it. Improved methods of ore treatment have made possible the exploitation of mineral deposits formerly unworkable because of complexity of composition. Costs have been reduced both by improvements in transportation and by advances in mining and metallurgical methods. Thus the mineral wealth of a large part of the Canadian Shield has become suddenly available at a time when the productivity of some of the older and more easily accessible ore deposits of the world is beginning to decrease.

From a national point of view it must be realized that this period is transi-

tory, since it is based on wasting assets. It may however be prolonged for a very considerable period by new discoveries, and by thorough utilization of those now being mined. The mining industry of the Canadian Shield has been of inestimable value to Canada, especially at this time when the marked increase of gold production has served to offset the conditions in other basic industries. The mineral resources have made possible, or have accelerated, the settlement of some parts of that vast area. By the time the mineral deposits are exhausted permanent communities may have occupied the tillable areas, and other industries may be established based upon water-power resources developed originally for the mines.

The inception of mining industries in parts of the Canadian Shield far removed from railway or adequate water transportation introduces another factor into the problems of national economy. It is evident that only deposits of unusual types or of exceptional richness can be mined. The deposits of radio-active minerals at Great Bear Lake can be exploited profitably since the tonnage of ore involved is small and since world production of radium is also small. It is conceivable that silver deposits similar to those at Cobalt or gold deposits of high grade might also be mined profitably even in remote parts of the Shield, since the output could be brought out by air even though the transportation costs were high. It is clear however that only rich ore could be treated, and even deposits such as those at Cobalt, if located at a point as remote as Great Bear Lake, would have been workable only for high-grade material.

To extract only the richer parts of any such deposits would prevent for all time the mining of associated lower-grade ores. It would seem therefore that in some parts of the Shield mining should not be permitted unless the ore is such that it can be thoroughly utilized. For most ores development should await the extension of transportation facilities. There is perhaps an alternative: it may be possible so to improve and reduce the cost of air transportation that many ore deposits can be worked without undue loss of low-grade ore. At the moment it would seem that this is possible only for a few types of ore and with a generous subsidy by the Government. That however is preferable to wasteful exploitation of national resources, and can perhaps be justified on other grounds. A government subsidy would so far reduce costs that gold mines and possibly some other mines could operate at considerable distances from rail or water transportation on ore of medium grade, and it would at the same time make possible the extensive training of commercial pilots.

# THE FIFTH INTERNATIONAL CONGRESS OF PHOTOGRAMMETRY, ROME, 1938

ARTHUR R. HINKS, F.R.S., Sec. R.G.S.

THE International Society of Photogrammetry was founded by Professor Dolezal, of Vienna, in 1909, and since the Great War has held International Congresses at Berlin in 1926, Zürich in 1930, Paris in 1934, and Rome in 1938. By its Statutes of 1930 membership of the International Society is designed for, though not restricted to, the members of national societies of photogrammetry, of which there are nineteen. In countries such as our own which have no national society of photogrammetry, some interested society may become an "isolated member," and in that category the R.G.S. has for some years been enrolled, paying an annual subvention of twenty-five Swiss francs, and receiving its publications. The writer was designated to represent this isolated member at the Congress in Rome, and later was named by the Prime Minister as chief of the British delegation accepting the invitation of the Royal Italian Government. As things turned out his colleagues were kept at home by official duties, and the Secretary of this Society arrived in Rome as a delegation of one, but happily with the representative of the Committee for Photogrammetry of the Survey Institute of Canada (ranking as the national society) to stand for the British Dominions.

The Congress was housed in the Scuola di Matematica of the new Città Universitaria outside the Porta Pia, and its work was divided between eight commissions. By the kindness of Professor von Gruber we have received a transcript of the report of the work of each commission made by members of the technical staff of Zeiss-Aerotopograph, and it will be possible to give at a later date some account of the conclusions. This left the single Englishman free to spend most of his time in the international exhibition of instruments, methods, and results organized by a second Italian committee to run parallel with the Congress. Of the nineteen countries adhering by their national societies to the international, fourteen had taken space in the exhibition; eight separate departments of the French Government, six each of the Italian and German, and one or two of eleven others showed applications of photogrammetry to their special problems; three Italian, two Swiss and German, and one French firm of constructors showed plotting machines and accessories; eight French companies, three German, two Italian, and one each from Belgium, Sweden, and Switzerland showed commercial applications of photogrammetry. There was no British exhibit, either official or commercial: nothing to show that the Air Survey Committee have developed and made great use of a simple and relatively inexpensive method of plotting with the Barr-Stroud field stereoscope; that they have designed and the Cambridge Instrument Company constructed an improved stereocomparator for air triangulation which in their opinion is better suited to British needs than the more elaborate plotting machines now so extensively used elsewhere; or that they have had in use for some years a stereogoniometer on the Fourcade principle, a principle so well known in the history of stereogrammetric methods, but of which so little has been seen in practice; or that they have

designed and built, and indeed described in the *Empire Survey Review*, a multiple lens camera which seemed to have great possibilities. Nor was there any sign in the exhibition of the Williamson Manufacturing Company's Eagle camera, which is the standard machine in British use and not unknown elsewhere; or of the new wide-angle lenses made by Messrs. Ross which have obtained such remarkable certificates from the National Physical Laboratory. British contributions to the science and art of photogrammetry have been on different lines from those followed by the leading Continental exponents, and that is all the more reason why they might have been shown at Rome.

Our country has not however anything to show to be compared with the great stereoplotting machines that have made such an impressive appearance in the displays of France, Germany, Italy, and Switzerland. Italy had two, the Santoni and the Nistri. We had seen an early model of the former at the Istituto Geografico Militare at Florence in 1926, and it was most instructive to see at Rome the complete series from the even more primitive model of 1920, and to enjoy the enthusiastic demonstrations of the inventor, Major Santoni himself. This is one of the machines which works by mechanical reconstruction of the rays from a pair of photographs, as in the Zeiss Stereoplanigraph, the Wild Autograph, and the Poivilliers Steréotopographe. It is made by the S.A. Officina Galilei of Florence, who make also the Stereosimplex, a less elaborate machine of the same kind, designed as an auxiliary to the larger machine to deal with the conjugate plates of a multiple camera when the air triangulation has been made from the principal plates; and also, since it is easily dismounted, to do the whole job in the field when necessary. A new instrument by Major Santoni is a multiple camera with a solar attachment which takes an image of the sun on the plate, from which some of the elements of position may be derived. This was the subject of a communication to Commission 4 which will be studied with much interest. The Istituto Geografico Militare showed a series of maps on scales 1/25,000 and larger, and diagrams representing the areas surveyed from 1935 to 1938 in Italy and her overseas possessions.

The other half of Italy's extensive display was devoted to the Nistri machines and their employment for the Direzione Generale del Catasto and other Departments of State by the Ottico-meccanica Italiana e Rilevamenti Aerofotogrammetrici S.A. of Rome. The large Nistri machine projects a composite image from the pair of photographs, which are alternately obscured so that the image flickers rapidly except at one point or along one contour, which by manipulation of the controls can be followed in the image and drawn automatically upon the plotting table. One is assured, but not altogether convinced, that the method is not so trying to the eyes as it may look. However that may be, the company can show a long range of the machines hard at work, and a rapidly increasing output of cadastral and other plans. A simpler form of the machine dispenses with the flicker and allows the operator at the controls to bring the desired point into focus in a field otherwise confused.

An important historical section of the Italian exhibit displayed the first photogoniometer and other early instruments designed and made by Porro between 1850 and 1870, and the photo-theodolite of Paganini by which a survey of the Cave di Colonnata was made in 1878. An astronomer may remem-

ber with pleasure that the first extensive photographic survey was that of the stars, made by Kapteyn of Groningen with a photogoniometric machine he built about 1890. That machine must not be forgotten when the history of photogrammetry is written.

The essence of the photogoniometer is that the plate is viewed through an objective identical with the objective that took it, so that one is compelled either to restrict oneself to a single focal length of camera, or to have an expensive series of objectives and chambers on the plotting machine corresponding accurately to the cameras used in the field, or to rephotograph the plates precisely to a standard focal length. The most beautifully contrived plotting machine ever made, the original Autograph of Heinrich Wild, described in the *Geographical Journal* for October 1927, could not be made to deal with the larger plates and the wider angles now commonly employed. The new Wild Autograph Model 45 was shown for the first time at Rome, and was the most exciting thing in the exhibition, for it has abandoned the photogoniometer and realized a purely geometrical solution applicable to plates with a wide range of focal length and angular aperture. It can deal with plates inclined to within a few degrees of 45° either to vertical or horizontal; it moves with the sweetness to be expected from the makers of the older Autograph, and bids fair to be the universal instrument so long desired. It costs several thousand pounds, but a good deal less than the Stereoplanigraph; it is compact, and has much of the elegance of its predecessor; its designers and constructors must look forward confidently to its future.

The firm bearing the eminent name of Heinrich Wild showed also a simpler instrument designed for work at short distances, particularly for police work in the record and study of motor accidents, studies of which some lurid examples were exhibited; and they had as well the beautiful series of four carefully graded theodolites, from the simple $T_0$ reading to a minute to the high-precision $T_3$ reading to tenths of seconds. What was altogether new to many of us and most surprising was to see on the neighbouring stand of Messrs. Kern of Arau another series of three theodolites neatly interpolated between the above four, with an announcement that they were manufactured under the patents of Dr. Heinrich Wild, embodying important improvements in principle. The most evident was a telescope of large aperture with a concave mirror in the optical train, shown without comment or opportunity of examining such a remarkable innovation.

In the exhibit of Zeiss-Aerotopograph G.m.b.H. of Jena the central object was necessarily the Stereoplanigraph, of which there is little new to say. Its design seems to have reached finality; it is widely used, admirably adapted to regular surveys with standard cameras, and has only the drawbacks mentioned above as inherent in instruments of the photogoniometer type: those, and its great cost. As an auxiliary to it, when the air triangulation has been made, there is the Multiplex projector, a series of projecting cameras adjusted to the triangulation, giving overlapping pictures in complementary colours, which show the ground in relief when viewed with correspondingly coloured spectacles, so that the plan of detail and the contours can be interpolated in the triangulation and drawn automatically with sufficient accuracy for most purposes, somewhat as in the corresponding Nistri instrument. Its use seems

in practice to be nearly limited to approximately vertical pictures, or perhaps to obliques at a nearly constant obliquity.

To its range of photo-theodolites Zeiss-Aerotopograph have now added a beautiful little instrument taking pictures 6·5 cm. by 9 cm. It will be remembered that the Mount Everest Reconnaissance of 1935 was organized at short notice when leave came unexpectedly from Lhasa. The Mount Everest Committee were resolved that this time there should be an accurate map of the north face of the mountain: so they borrowed the Wild photo-theodolite from our Society, a lighter Zeiss photo-theodolite from the Danish Geodetic Institute, and as a last-minute improvisation attached a Leica camera to a light mountain theodolite by Watts to make a third photo-theodolite, light enough to go above 20,000 feet. As the Watts-Leica photo-theodolite this instrument has done some very useful work, twice on Mount Everest and once on Nanda Devi. No maker paid any attention to it in the land of its improvisation, but Zeiss-Aerotopograph showed me at Jena in September 1937 the designs for a perfected model, and the first example of the finished instrument was on view at Rome: a beautiful little thing, but unfortunately costing a great deal too much.

The stereogrammetric surveyor has never in the last twenty years had any need to search for instruments of high precision. They have been thrust upon him by the enterprise and keen rivalry of Swiss and German constructors: exhibited at every Congress, demonstrated by competent technical staffs, extolled with all the arts of salesmanship and propaganda, if one likes to put it that way; but surely justifiably, for they are magnificent machines. The only question can be, Are they unnecessarily complicated and therefore expensive? Have people been persuaded into buying them and afterwards regretted it? Have the English-speaking countries kept their heads while others have been over-persuaded, or have they been too dull or too poor to appreciate what every one else has thought is a good thing?

These questions were discussed in a very frank and instructive way by Professor Schermerhorn in a paper read to the Geographical Congress at Amsterdam, reprinted in his new journal *Photogrammetria*. He left the answer open, and in the exhibition at Rome showed nothing whatever of the work he is doing at Delft, of which one had heard so much from those who were at Amsterdam in July (see *Geogr. J.* 92 (1938) 6–8). As Professor of Geodesy in the Technical High School, and adviser in surveying to his Government, he is allowed to run his department on commercial lines, undertaking large contracts for oil companies in New Guinea and elsewhere. The Netherlands Government started his institute with a Stereoplanigraph, which was kept so busily at work that a large contract had to provide for the purchase of a second. Both these machines are operated twenty-four hours a day in three shifts, doing almost entirely air triangulation. A third machine, the new Wild Autograph Model 45, has recently been added. Yet very few contour lines have been plotted on these big machines: there was too much else to do, and the Zeiss Multiplex took on the relatively rough contouring required in forest-clad New Guinea. There are however in this one institute three first-class machines, and Professor Schermerhorn speaks of his positive knowledge that these machines are economical.

He is equally emphatic that air photography is not, if it is used mainly for making topographical maps. The biggest air surveys in the world, in the Dutch East Indies, are made for rapid geological reconnaissances (for oil companies). The same plates, transferred to the Government, serve for forestry, studies of population distribution, road building, choice of government stations, irrigation projects. At some time or other they may be used for topographical mapping, almost as a by-product. "Some day every survey made in undeveloped countries by terrestrial methods will be regarded as a sin against the interests of the people, not because the old topographical method is not adequate or is too expensive, but because the opportunity has been missed of complementing the economic tools of the people by a new and highly useful one."

The big plotting machines are economical even for surveys by vertical air photographs which can be and are dealt with fairly well, if not so economically in time, or so accurately, by the simpler machines used by English and Americans; so long as a big machine which can deal with plates of nearly any obliquity is used only for near verticals a great part of its power is lying idle. This may not interest the systematic air surveyor with his near verticals, but it does interest very much the geographer who wants to deal with high obliques, like the photographs made on the Mount Everest flight, or on the British Graham Land Expedition, or by Gino Watkins in East Greenland, or the American Geographical Society party in northern Labrador. And it should certainly interest the military topographers of to-day, who cannot expect to fly undisturbed to take verticals over unfriendly territory. Moreover the universal machine can be used for plotting stereoscopic pairs of photographs taken from land stations with a photo-theodolite: the original form of photographic survey, imagined and practised long before any one had flown, now fallen into the background of recent technical literature, but much used on the Continent for mountain surveys, topographical and geological, for record and profiles of architecture, for planning water-power installations, for studying motor accidents, the shape of suspended cables under moving loads, and many other things.

When the Society bought the Wild photo-theodolite and sent it out to Major Mason for his Shaksgam work there was no plotting machine in England that could deal with the plates; they were taken to Switzerland. Twelve years later we are still obliged to send plates to Switzerland: Mr. Spender is at this moment of writing at Heerbrugg working up Mount Everest Reconnaissance plates on the new Wild Autograph, whose use has been hired for a few weeks. We have never been able to make full use of the obliques from the Houston Mount Everest flight of 1933 to plot the contours on the south face of the mountain.

But I may perhaps be allowed to put on record here the conclusions to which I have come as the result of my visit to the Photogrammetric Congress and Exhibition at Rome.

For the future work of the Society, it will want, when it can afford it, to instal and staff a machine that can deal with the very miscellaneous material already available but never yet utilized, some of it mentioned above, and to which we may add that part of the British Arctic Air Route Expedition plates

not already worked up at the Danish Geodetic Institute; plates taken with the Society's photo-theodolite by an Oxford University expedition in West Greenland last year; and the material which will certainly come in year by year, some of it from ground stations, much from oblique air photographs, taken with cameras of different focal lengths, with slight ground control if any, and without any strict plan; miscellaneous photographic reconnaissance of all kinds not capable always of giving high precision, but geographically invaluable. The machine on the market that will tackle it most successfully is probably the new Wild Autograph Model 45, expensive, and one may say unnecessarily good for much it would have to do at first; but not too good, and cheaper in the long run, for what it might very well have to do in a few years if British explorers are encouraged by the knowledge that the Society is prepared to tackle everything that comes to hand.

A much larger question is, What should be the official British attitude to photographic surveys, from ground or air? In the past it has resisted any attempt to introduce into Great Britain the elaborate plotting machines so extensively used on the Continent of Europe. The reasons are well displayed in the many discussions reported in the *Geographical Journal*. A principal argument has always been that if such machinery is to be used, it should be developed at home and not bought abroad. But development at home has made little progress. The one large plotting machine constructed has been relegated to the Science Museum as a relic. British makers have been willing, if at all, to build machines to order, which means that if the machine is not a success the customer pays for the failure. Meanwhile the enterprise and rivalry of Continental constructors have produced machines which by continual trial and experience have become mechanically perfect. No one who saw the exhibition at Rome and talked with people there could doubt that there is a great and varied future for stereogrammetry, that the big plotting machines have proved their value, and that there is no need to waste time and money in planning a new all-British machine until one has had some experience of the others.

It seems certain however that we must not think of photogrammetry only as a method of topographical survey. To photograph a country from the air for a single purpose and allow the plates to be lost is wasteful, and the cost discouraging; but this waste is inevitable unless such photographs are made a national service, and all the information they contain, much more than can be put upon a map, made available for administrative and economic use. The essential point is that all photographs for record should be so taken and preserved that they may be measured accurately if and when required.

There is not in the whole of the British Empire any stereographic plotting machine in use, either for ground or for air surveys. Nor is there any organization for the orderly prosecution of photography from the air, with a view to its complete use in the economic development of a territory. Air photography for a single purpose is very expensive, but if the full use is made of the photographs, and the cost of the service divided between the various interests that benefit, they must in the end more than pay for themselves.

Since we have not at present any adequate supply of photographs for study, it has been urged that we should first provide the photographs, and then the

means of studying them. In my opinion this argument is ill-founded. It should not take so long to create Air Survey units as an establishment to deal with the photographs, since we know in Great Britain much more about the former than the latter.

My conclusion is that one must study the possibility of establishing in Great Britain a central organization for undertaking photogrammetry of all kinds to meet the future requirements of different Departments of State, local authorities, and commercial interests. Such an establishment should command the requisite Air Survey units fully equipped and trained for work in any part of the world, and a section equipped for ground photogrammetry. Their instruments should be standardized and calibrated so that plates could be used as required, not necessarily at once, for the many purposes to which such photographs are now applied for national, local administrative, and commercial purposes, including topographical mapping.

The plates should be preserved in store at headquarters which should be equipped with those plotting machines, of whatever origin, that have proved themselves most useful in large operations, such as at Delft, and with a trained staff competent to undertake without delay, for appropriate payment, any studies of the plates desired, normal or special.

Such a central establishment would form a pool of machines, instruments, methods, and trained personnel ready for any service. A small research staff would study new methods wherever developed and adapt them to the needs of the establishment. If well started and properly run such an establishment should be nearly if not quite self-supporting, as the National Physical Laboratory soon became.

# A SURVEY OF CHINA

LAND UTILIZATION IN CHINA. By JOHN LOSSING BUCK. (A report in the International Research Series of the Institute of Pacific Relations.) *Nanking: University of Nanking* (*London: Oxford University Press*), 1937. 9×6 *inches;* xxxii+494 *pages; illustrations and maps.* [Vol. II] Atlas. 17½×12 *inches;* xii+146 *pages.* [Vol. III] Statistics. 18½×12 *inches;* xvi+474 *pages.* 21*s*, 21*s*, 42*s*, *or* 63*s per set*

WITHIN the space of a short review it is difficult to do justice to a work which, as in this case, may be truthfully called monumental. The survey owes its origin, like several others, to a suggestion made by Dr. O. E. Baker at the Conference of the Institute of Pacific Relations at Honolulu in 1927 and was carried out by a special staff controlled by Professor J. L. Buck, of the Department of Agricultural Economics of the University of Nanking. The avowed objects of the survey were to train students in research, and to make available a knowledge of China's agriculture both as a basis of national policy and for the information of foreign countries. In a country of 1,500,000 square miles, lacking both a population census and adequate detailed maps, the only possible method was one of sampling. Hence the survey is based on a study of 16,786 farms in 168 localities and 38,256 farm families, selected from each of the 22 provinces of China proper. The field work was carried out in 1929–33. Throughout there has been close cooperation between the Director, his Chinese and American colleagues, and such foreign experts as James Thorp, C. F. Shaw, and R. L. Pendleton (soils), J. Hanson-Lowe, C. B. Cressey, and H. Brian Low (geography), W. S. Thompson (population), and David Weeks (agricultural economics), who visited China during the course of the investigations. There has also been close cooperation with the Institute of Pacific Relations.

The results of the survey now appear in three volumes: an octavo volume of text in English, a finely produced atlas in English and Chinese, printed in Shanghai, and a large volume of statistics in English and Chinese. Each of the three volumes has wisely been made self-contained; the volume of text has an adequate number of tables and maps, and many photographs; the atlas, in addition to the very large number of black-and-white maps, has thirteen aerial photographs of the main types of land utilization.

Professor Buck has written the bulk of the volume of text which really forms the general report of the survey. His first chapter, on Chinese agriculture, in some ways summarizes the whole, and he concludes it by enumerating sixteen important policies suggested by the study. These are particularly interesting for their moderation; is is evidently the opinion of Professor Buck and his many American colleagues that American methods are in the main inapplicable to China with its superabundant labour supply and its distinctive systems of intensive agriculture. "Any attempt at major changes in organization such as collective or other large-scale farming should be undertaken only on an experimental basis and on a very limited scale." Thus the major suggestions concern such universal needs as flood control, irrigation, soil conservation, agricultural education, and control of standards. Whilst the need for agricultural credits is mentioned, China does not suffer from the indebtedness of the peasant farmer as does India. Over one-half of the farmers own their land, one-third are part owners, and only 17 per cent. tenants. On the other hand China shares with India the evils of land fragmentation with a consequent waste not only of effort but actually of land on boundaries. Ancestor veneration is responsible for the sterilization in graves of 2 per cent. of the good land, and it is calculated that

release of this land, elimination of boundary tracts, and terracing or irrigation could add 25,000,000 acres to the cultivated area. The average size of the Chinese farm is 3·31 acres, but the area harvested, allowing for double cropping, is 3·58 acres. Most farms are of course worked by hand labour with animal labour a poor second, and it seems that Professor Buck would regard the extensive introduction of machinery as creating more problems than it would solve.

China is regarded as divisible into two major agricultural regions: the wheat region and the rice region. These coincide with the common division into north China (wheat), and central and south China (rice), in that the Yangtze basin is included in the rice region. Eight sub-regions or "areas" are suggested which correlate closely with the regions commonly used by geographers. In his account of the topography Hanson-Lowe has however introduced some original conceptions, illustrated by a sketch-map of the major topographic units. His perpetuation of Prince Kropotkin's use of the term "terrace" to denote the major plateau units is perhaps confusing, but the subsequent analysis is valuable.

At the International Soil Congress at Oxford in 1935, it was urged in discussion that the soils of China should be studied *de novo*, rather than that they should be made to fit into existing world groups. Thorp's chapter on soils rather suggests that this is justified: he finds that the soils of the north are mostly leached soils belonging to Marbut's "Pedalfer Group," and that those of the south are unleached or slightly leached soils of Marbut's "Pedocals." Beyond that the classification used is largely a local one except in the north, where climatic conditions approximate to those of corresponding latitudes in North America with a consequent development of chestnut earths, chernozems, desert soils, solonetz, and solonchak. Thorp's investigations on the red-earth group of the south are helpful to workers in India and he wisely avoids a partisan attitude in the disputed question of laterite; he explains the position and then proceeds to use the non-controversial term "red earth." The relatively low fertility of tropical red-earth soils is reflected in a surprising map showing the percentage of total land cultivated. Over most of south China this percentage is under 20; over the major hill and plateau regions (including Yunnan) it is under 10. Only in the Red Basin and the northern Plains does it average over 60 per cent. Some years ago Dr. Baker estimated the cultivable area of all China (not at present cultivated) at 700 million acres. The present survey reduces this figure to 35 million acres, and confirms that most of the land already suitable is cultivated, an estimated total area of 232 million acres.

The maintenance of soil fertility by the use of human manure is defended, though its relationship to the spread of disease—especially intestinal diseases transmitted through the bare feet of farmers—is stressed. By contrast, it is urged that oilcake commonly used for direct fertilization would be better used if first fed to animals.

Throughout the report comparisons are made with American conditions, less frequently with British. In some sections American and British viewpoints would differ; not only is the whole economic organization of land use more closely allied to the intensive agriculture of Europe, but also the standard of comparison in the chapter on nutrition being American a wider divergence is revealed than would be the case with a European standard. Indeed this whole chapter suggests how much has still to be learnt in the study of diet. The bulk of the Chinese intake of food-energy is of vegetable origin (up to 98 per cent.); for the American farmer the intake is 60 per cent. The Chinese diet is regarded as "more bulky, lower in fat and less digestible than the mixed diet of westerners." Adding leafy vegetables would simply add to bulk, so strained vegetable and fruit juices are suggested, especially for children. Here it is surely

legitimate to ask whether the western scourge of indigestion has reached China and, if not, whether the deductions regarding nutrition are justified.

Some of the findings of the survey may occasion surprise, notably the high taxation of the peasant farmer and the fact that he must produce cash crops to enable him to purchase one-quarter of his food requirements, showing that the Chinese farm is already far removed from self-sufficiency. Transport costs represent 85 per cent. of the cost of marketing cash crops; carrying by human porters is still the commonest of the methods of transport, though it is shown to be the most expensive. At present goods are only carried an average distance of 7 miles to market. Clearly it is in the development of roads and railways and in the already rapidly increasing use of motor transport that the greatest developments are to be expected in China. L. D. S.

## NEW PTOLEMY STUDIES

TEXT UND KARTEN DES PTOLEMÄUS. By PAUL SCHNABEL. (Quellen u. Forschungen zur Geschichte der Geographie u. Völkerkunde. Band 2.) *Leipzig: K. F. Koehler*, 1938. 9×6 *inches;* viii+128+viii *pages; facsimile maps. M.*10 (*unbound M.*8)

THEORIE UND GRUNDLAGEN DER DARSTELLENDEN ERDkunde (I und II Vorwort). Des Klaudios Ptolemaios Einführung in die darstellende Erdkunde. Erster Teil. ("Klotho." Edited by F. W. KÖNIG. Bd. 5.) Translated and edited by HANS V. MŽIK, with FRIEDRICH HOPFNER. *Wien: Gerold and Co.*, 1938. 10×7 *inches;* 110 *pages; diagrams*

THE intensive study of the great Alexandrine geographer, to which Josef Fischer looked forward on the completion of his own monumental work some seven years ago, is making steady progress, and two independent contributions, each of great value, have been inaugurated by the works here reviewed. They start from different standpoints, the aim of Professor Schnabel being to establish the most authoritative Greek text by a meticulous study of the MSS. and their relationships (thus carrying to completion the task begun last century by Carl Müller, but interrupted by his death), that of Herr von Mžik to supply for the first time a complete translation into German based on the best recent studies, which have given the subject a new foundation since the time of Nobbe and others. It might be thought that the latter effort should have waited till the full results of Schnabel's work were available, but this might have meant indefinite postponement, and as the translator is fully cognizant of the results of recent research so far published, his version may be trusted to give in the main the substance of the original as it left its author's hands.

Professor Schnabel's knowledge of the existing texts is probably unrivalled, his study having been carried into greater detail in some directions than even that of Fischer, from some of whose conclusions he dissents, while fully realizing the outstanding merits of his work. The present memoir is preliminary to the main work contemplated, being an attempt to establish, so far as is possible, the pedigree of the surviving Greek MSS., and their varying degree of relationship with the earlier lost versions, including the true original. The opening section gives a careful description of each MS. in a sequence corresponding to the new classification put forward by the author, the reasons for which are discussed in detail later. He lays down two early "recensions," themselves divided into

"groups" and these again into "families," the last represented by MSS. that have come down to us—some through the intermediary of others now lost. He has elaborated a system of symbols to denote the several orders of succession down to the ultimate units, using for the purpose the letters of the Greek and Roman alphabets in their larger or smaller form. Such letters have in the past been attached to many of the MSS. as applied originally by Müller, but Schnabel finds it necessary to depart from Müller's notation to a considerable extent. He adopts the Greek capitals $\Xi$ and $\Omega$ for the early recensions, with $\Pi$ and $\Delta$ for the two groups derived from the latter, using the small Greek characters for the families, the Roman capitals for the most important surviving MSS., and small Roman for derivatives which have no independent value. To some extent he retains Müller's notation, the result being to depart somewhat from the most logical choice of symbols, for letters from quite different parts of the alphabet are used for units in the same group, while the same letter, in its large and small form, may fall into different families—thus s belongs to the family $\omega$ while, as is suitable, S comes under the family $\sigma$.

Most of the MSS. have long been known to students, but a few notes on the more important, in their new grouping, may be of interest. In the recension $\Xi$ we have X in one family and A and O in another, of which however O is in part derived from the other recension. X dates from the thirteenth, A from the first half of the fifteenth, and O from the early fourteenth century. X and A are preserved in the Vatican, O in the Laurentian Library in Florence, but all must have had prototypes now lost. Each of these must have had maps, though O only, of the existing copies, possesses them—the sectional maps being here the series of 64. It is shown that the Ambrosian MS. in Milan (which Fischer had planned to publish in facsimile) is merely a copy of O, a reproduction of which would have greater value. The Burney Codex in the British Museum, again with 64 sectional maps, is also a but slightly altered version of O.

Of the $\Pi$ group of the $\Omega$ recension, that labelled Z is now in the Vatican, having been brought from Heidelberg among the spoils of the Thirty Years War. It has no maps, but R, written at Nauplia and brought to Venice by Cardinal Bessarion, has an incomplete set of the 26–7 sectional series. The $\Delta$ group is the largest of all, including, among others, the Urbinas 82 at the Vatican reproduced by Fischer (U), that lately found at Constantinople (K), and the Mount Athos version (L). This last is based on U and therefore has no independent value for textual criticism, but it has some importance, as is shown below. It must have had another home before coming to Mount Athos. N, now at Oxford, came originally from the Khalki Island monastery in the Sea of Marmora. Three versions (S, P, and B), all in the Laurentian Library at Florence, form a family of their own, based on a lost prototype, of special interest because it was used by Angelus for his translation into Latin. It is again a mixed text, based on both recensions. A second Oxford MS. in this group (o) is relatively unimportant as it is a slavish copy of another, itself derived indirectly from U, as is also the Paris MS. D in part. The earliest in this group is U, written in the early thirteenth century, K coming next in the second half of the same, and L third about the end of the thirteenth or early fourteenth century.

The arguments by which the order of succession is established are most ingenious, and appear as a rule acceptable. They are based mostly on the extreme minutiae of textual criticism, and we must be content to give here a general indication of the lines followed, with a few concrete illustrations. Note is taken of the evident corruption of passages when such is common to several of the texts; of late insertions incompatible with Ptolemy's own views; of differ-

ences between text and maps in one and the same version; of differences in the form of place-names; and so on. An interesting point is brought out in regard to A—the version used by Erasmus for the first printed edition, edited by him, the history of which can be traced in detail. From the number and position of the blank leaves in the MS. it is shown that the original intention had been to include the 64 sectional maps, and the world-map, typical of one group, but that it was never carried out. As regards X it is shown, from the occasional interchange of scripts in it, that the three scribes responsible must have worked in conjunction. Reviewing previous attempts at classification, Schnabel finds defects in each, and regards Cuntz's as quite untenable (though some of his other conclusions are sound). Schnabel holds that Fischer erred in laying so much stress on the value of the fine Urbinas MS. reproduced by him, for its readings are in parts corrupt, and inferior to those of the Constantinople MS. (K); this was discovered in 1930, too late to be fully considered by Fischer, but is unfortunately incomplete and in places illegible.

The following are among the conclusions of more general interest arrived at by Schnabel. The approximate date of origin of group $\Delta$ is put down as fifth or sixth century A.D., a view based on a comparison with the anonymous 'Diagnosis' printed by Müller in his 'Geographi Graeci Minores,' of which the Mount Athos Ptolemy (belonging to the group in question) was a forerunner. The originator of this group is held to have been a Christian by reason of the form of certain names, in Palestine and elsewhere, which is that used in the New Testament. The place of origin must have been Constantinople, for this group alone takes special account of the parallel through that city, which does not fall naturally into Ptolemy's original series. On the other hand the recension $\Omega$ must have originated in Alexandria, as it departs from Ptolemy's practice in using this name as the label of one of the seven "climates." Concrete instances, it may be noted, are given of the help towards getting at Ptolemy's own ideas afforded by a comparison of the two recensions, while conclusions are also drawn as to the authenticity or otherwise of certain features. Thus the emphasis given in some MSS. (by a device of the script) to the most famous cities, is truly Ptolemaic, being in general accord with the 'Canon of famous cities,' supplied by Ptolemy in his 'Astronomical hand-tables.'

Of interest also are the conclusions as to the maps, general and special, which have come down to us. The general map is held, as by Fischer, to be non-Ptolemaic in its known form, but is considered the work of the editor of group $\Delta$: Schnabel rejects Fischer's view that it is to be ascribed to Agathodaemon, holding that both his map and Ptolemy's original are alike lost. Of the regional maps, he puts down the 26 of Recension $\Omega$ as really Ptolemy's in the first instance, though they bear traces of later revision. The 64 of certain MSS. cannot have been formed by subdivision of the original 26, but must have been constructed independently, at an early date, on the basis of a lost MS. of Recension $\Xi$.

Enough has been said to show the importance of the memoir, whether all the conclusions be accepted or not. Although only running to 128 pages it is packed with solid matter, which can with difficulty be assimilated by any one who has not himself made a special study of so complicated a subject. It is to be hoped that Professor Schnabel's health, which compelled him to leave to the general editor of the series, D. A. Herrmann, the task of seeing the memoir through the press, may be sufficiently restored to allow him to proceed with his further programme of bringing out the complete text as established by him, with full references to the *variae lectiones* of the MSS. To Dr. Herrmann we owe a useful genealogical table of the Greek MSS. on the basis of Schnabel's work, and also

a selection of maps from the Constantinople MS. K, now reproduced for the first time.

The second work under review, important as it is, calls for less extended notice, as it purposely avoids discussing controversial matters, and the translator's notes are limited mainly to points needing explanation in the interest of the general student. Herr von Mžik's previous record justifies confidence that he has reproduced Ptolemy's own meaning so far as it is possible to get at it. The present instalment includes Book 1, concerned with the general principles of map-making, together with Ptolemy's preface to the special topographical part, with which Book 2 opens. In regard to the main substance of this part, to follow in due course, some may perhaps criticize the decision of the translator (here announced) to depart somewhat from Ptolemy's own arrangement in order to bring together more systematically countries naturally associated with each other. This may be a cause of worry to those conversant with the original order.

In his brief introduction the translator dwells on the character of the work as an "Introduction to map-making," and not a "Geography," though the latter term is commonly applied to it: its intention was to help to a portrayal, not a description, of the world. He insists on the magnitude of the world's debt to Ptolemy—rather than to his predecessor Marinus—for supplying the logical basis of scientific cartography which has not been upset down to the present day. As previous discussions and criticisms of the projections used by both Marinus and Ptolemy have, he thinks, missed their mark to some extent, he has called in an expert on the technical side, Dr. F. Hopfner, who discusses the matters at issue in a series of useful excursuses. This is not the place to enlarge upon their mathematical basis, which requires some technical knowledge. Perhaps the most important is that dealing with Ptolemy's two conical projections—the true, with rectilinear, and the modified, with curved meridians, the latter closely resembling that generally known as Bonne's. As is well known, Ptolemy regarded the second as preferable, though Dr. Hopfner is inclined to question this. Both are remarkable contributions, considering the limited mathematical apparatus available in the second century. Dr. Hopfner doubts however whether, considering the lack of trustworthy observations of position in those days, either of the two was so much more useful than the simple cylindrical projection used by Marinus, which Ptolemy himself recommended for restricted areas. In later times, Ptolemy's first projection was used by Mercator for his big map of Europe in 1554, the second by Sylvanus for the general map in his Ptolemy of 1511, and with modifications by many later map-makers. No mention is made of Waldseemüller's big map of 1507, often spoken of as following the second projection of Ptolemy, possibly because of its failure to adhere strictly to the model. E. H.

# REVIEWS

## EUROPE

THE PERSONALITY OF BRITAIN. By Sir CYRIL FOX. Third edition, revised, with additional distribution maps by LILY F. CHITTY. *Cardiff: National Museum of Wales and Press Board of the University of Wales*, 1938 (*first published in* 1932). $10\frac{1}{2} \times 8$ *inches;* 98 *pages; illustrations and maps.* 4*s*

That this admirable introduction to the human geography and early history of Britain should appear within six years in a third edition is evidence both of its importance and of its popularity. It is the more welcome because opportunity has been taken for careful revision and for some valuable additions. The sections which deal with the subsidence of Britain and the land bridge with the Continent, and with the exploitation of forest lands, have been rewritten, and some other passages expanded. Six distribution maps hitherto unpublished, the work of Miss L. F. Chitty, have been added, and two more reprinted from elsewhere: they represent large masses of detailed information in impressive form. There are three new pages of drawings illustrating the chief individual type-objects of which the distribution is given in the maps; and Miss Chitty has brought other maps up to date. Full account has been taken, in footnotes and in small changes in the text, of recent archaeological and geographical work; but it is remarkable how well the general argument stands. Fortunately cooperation between museums has become much closer, so that the great wealth of stored material can be correlated and given its long-delayed interpretation in the numerous distribution maps which are the distinctive feature of this book, and which substantiate the author's reconstruction of the conditions of life, for settled populations as well as for invaders.

Since the first edition the date for the severance of Britain from the Continent has been put back considerably, though there is still room for doubt on details, especially as to the earliest submergence of coastal "forest beds." This subsidence continued till the close of the Bronze Age; its amplitude was not great, and was fairly uniform, in south-east England at all events; and the conclusion now submitted is that though the Channel route from Atlantic seaboards to Scandinavia was open much earlier than Sir Cyril Fox formerly contended, it was a more risky passage than now, by reason of currents and shoals on either hand; and at the same time the transit of invaders and their cattle from the Continent was much easier, especially in "Neolithic A" times and the period of the "Beaker-folk" movement. Progressive erosion of beaches along the narrows has destroyed much evidence of human settlement and movement in the district where it was most significant and copious.

Similarly great advances in the study of plant distribution, and especially of plant associations, have given precision to the picture of early landscapes, and especially to the extent of forest as distinct from parkland; and greater account has to be taken of other types of vegetation, characteristic of poor and porous soils—heath, moor, bracken, and "dry" oakwood, so different from the "damp" oakwood of the heavy clays, with its dense and often prickly undergrowth. These and similar considerations modify appreciably the interpretation of early distributions of human handiwork, and also explain some of their anomalies. Probably there are further refinements and modifications awaiting us; certainly the old simple antithesis of downland and woodland is obsolete; but the value of such a book as this is less in the permanence of its portraiture than in its illustration of the conception which gives it so suggestive and instructive a title.

J. L. M.

VOYAGING DOWN THE THAMES. By CLYDE EDDY. *New York: Frederick A. Stokes Co.*, 1938. 9×5½ *inches;* xiv+318 *pages; illustrations and route-map.* $3.50

A voyage down the Thames from Thames Head to the Nore light is well described by the author. The subject has of course been treated many times by English authors, but the American point of view gives it a distinct freshness. In spite of chequered weather Mr. Eddy enjoyed himself, and is enthusiastic in retrospect. He was busy with his camera, some excellent results being included in this book. He has an attractive style, and has collected historical information with accuracy and thoroughness. Many a native devotee of the river could pick up from these pages much of interest which is new to him. Even the most trivial details of the journey as described seem to have attraction. If there is a weakness it is on the side of archaeology, but this is excusable. It seems unlikely that a Roman garrison held Sinodun Hill for three and a half centuries; that the Dyke Hills at Dorchester were thrown up before the Romans came; that the Wallingford ramparts are of Roman origin; that the Icknield Way was a "great Roman road"; and that Danesfield, Medmenham, was the site of a Roman camp. S. E. W.

WILD ANIMALS IN BRITAIN. By FRANCES PITT. (The British Nature Library.) *London: B. T. Batsford*, 1938. 9×5½ *inches;* viii+120 *pages; illustrations.* 8*s* 6*d*

WILD COUNTRY: a highland naturalist's notes and pictures. By F. FRASER DARLING. *Cambridge: University Press*, 1938. 9×6½ *inches;* viii+104 *pages; illustrations.* 10*s* 6*d*

Miss Pitt's book is a guide to the mammals of Britain. Her aim is to present a readable and concise description of each species, its character and mode of life. The common forms of the countryside, fox, badger, weasel, for example, are fully dealt with. Those of the ocean, whale, dolphin, porpoise, etc., receive much briefer notice. Reference is also made to the species lost within recent times. The accounts are clear and accurate, and they are liberally supplied with first-hand information, for Miss Pitt has kept as pets and carefully studied many of our British species. Good photographs, four colour plates, and a number of woodcuts illustrate this useful book.

Dr. Fraser Darling's work is mainly a picture-book. Eighty-two nature photographs, many of which are very fine, illustrate the wild life of the Scottish Highlands. Some are pictures of natural scenery, such as crags, moorlands, waves rolling on the beach. The most impressive illustrate animal life, mainly birds and beasts that haunt the seashore. Suitable comments are made on the pictures, such as brief descriptions of the wild scenery, notes on the habits of the different animals, and here and there some specially interesting observations on the struggle for existence, and on the movements of birds' wings in flight. It increases our admiration of the author's photographs when we learn that all the pictures in the book were obtained without the use of a hide. R. W. G. H.

IRISH HOLIDAY. By DOROTHY HARTLEY. *London: Lindsay Drummond—Dublin: Browne and Nolan*, 1938. 8×5 *inches;* 272 *pages; illustrations and route-map.* 7*s* 6*d*

Miss Hartley hit upon an excellent idea when she took the Itinerary of Giraldus Cambrensis as a guide and companion through Ireland. Her constant comparison between the lore recorded by the twelfth-century traveller and the traditional versions which she heard from contemporary lips gives unity to her enthusiastic narrative. Observant and interested in the minor details of rural

life, she has set down her experiences simply and directly, and her book contains a good deal not to be found in more formal works. A book written "for light-hearted pleasure" requires to be received in the same spirit: it is sufficient to say that the author will undoubtedly convey her pleasure to many readers, though her style is occasionally a little too ecstatic. A word of praise must be given to her photographs, which have caught the spirit of the landscape. A reproduction of the British Museum Psalter map is erroneously described as the Hereford map. G. R. C.

EN VÄGBOK FÖR UPPSALA LÄN. *Uppsala: Almqvist and Wiksell*, 1937. 10½×7½ *inches;* viii+248 *pages; illustrations and maps*

In its Foreign Touring Guide the A.A. remarks of the roads of Sweden that "much remains to be done before modern standards of motoring comfort are reached." This book will explain to those interested why this should be in a country not otherwise backward in the cultivation of comfort.

After a general survey of the history of road-making in Europe by Gustaf Dahlberg, there is a fascinating chapter by Oskar Lundberg on the various kinds of ancient trackways and the traces left of them in place-names; for instance "Hällstig," meaning a track over rocks, is the name of one of Uppland's oldest roads, and is indicated in such names as Runhällen, Varghällar, etc. There are also detailed historical and topographical descriptions of a number of important roads in Uppland. In the next chapter Olof Svenonius gives an account of the making of roads and bridges in Uppland in historical times, of the laws governing their maintenance, and of the part played by individuals in their decay or development. In Sweden, as in other countries too no doubt, precept far outstripped practice; for though the authorities were willing enough to lay down laws and regulations, the burden of building and upkeep fell on villages and local landowners.

The fourth chapter, by Gustaf Dahlberg, brings us to modern times. The State has gradually been forced to assume responsibility for the building and upkeep of the roads, bridges, and ferries. Since 1921 the increase in traffic has been enormous, but, as the practice of the State has been to finance road improvement out of the funds provided by the various motor taxes collected in each administrative district, the condition of the roads has lagged far behind the needs of the present day. Another hindrance has been the easy access to temporary surfacing material, of which a quantity is provided by the typical "rullstensåsar" (rubble-stone ridges) of Uppland; but the problem of dust, among others, is prompting the use of more permanent surfaces. These "rullstensåsar" of Uppland are the main subject of the fifth chapter, by Professor Rutger Sernander, in which he pleads eloquently against their further ruthless destruction. The book closes with yet another plea, this time from the State Antiquary, on the subject of ancient monuments and their destruction by road-makers.

The book is illustrated by many interesting pictures and diagrams; there are tables of statistics too, but though technical it is never dull. It is a pity that only those acquainted with Swedish will be able to enjoy it. M. S.

ICELAND: a land of contrasts. By HJALMAR LINDROTH. Translated from the Swedish by ADOLPH B. BENSON. *Princeton (New Jersey) University Press (for) American Scandinavian Foundation, New York [London: Oxford University Press]*, 1937. 9½×6 *inches;* viii+234 *pages; illustrations and map.* 16*s*

The author of this book on the people and culture of Iceland is Professor of Scandinavian Languages at the Högskola in Gothenburg. The original Swedish publication, 'Island, Motsatsernas ö,' appeared in Stockholm in 1930, the year of the millennial celebrations in Iceland. The present translation, by Professor

Benson, of Yale, is not in the ordinary sense a new work, but an attempt has been made in this American edition to bring the facts and figures up to date. A certain amount of new matter has been added; some errors in the original text have been eliminated; and a number of new illustrations, which did not appear in the original, have been included.

Most of those who have any knowledge of the ancient classical sagas and poetry of Iceland have desired to know more about the country as it is to-day. They will find here fundamental information about modern Icelandic art, education, language, and literature. Professor Lindroth describes how the introduction of machines has affected the lives of the people; how the archaic and ultra-modern are engaged in a strange and violent conflict. Perhaps he dispels some of the romance of the island, but this does not make the picture which he substitutes any the less interesting. Improved communication with the rest of the world has caused revolutionary changes. A great effort is now being made to improve the condition of the people both intellectually and materially, yet there are differences of opinion among those in power as to how this can best be brought about.

This book is a wise compromise between accurate observation, sound scholarship, and popular appeal. The author and translator are to be congratulated on the thoroughness with which they have carried out their tasks. Both Professor Lindroth and his son, an entomologist, are authorities on Icelandic culture, and it is clear from the author's acknowledgments that he has availed himself of advice and help from highly qualified sources. B. B. R.

## ASIA

LA TURQUIE, PASSÉ ET PRÉSENT. By MARCEL CLERGET. (Collection Armand Colin. No. 213.) *Paris: A. Colin*, 1938. 7×4½ *inches; 208 pages; maps and plans. 15fr.*

This concise and careful study by one who knows Turkey from the inside gives a fairly adequate idea of the benefits which have accrued to the nation under the republican regime. M. Clerget describes the principal reforms already introduced and outlines the Government's plans for the near future. He suggests that "geographical factors are not always in keeping with the desires and plans of man," and gives a brief description of the geographical features and climatic conditions of the various regions. The dry climate and unsatisfactory hydrography of Anatolia constitute a grave obstacle to the development of agriculture so urgently needed in a country whose export trade depends almost entirely on the fertility of the soil. The authorities are endeavouring to introduce modern methods as a partial remedy, but passive resistance offered by the conservative peasantry is a stumbling-block. Nevertheless appreciable progress has been made. It is specially significant that Turkey no longer imports wheat, and even has a surplus for exportation. The section dealing with the development of industry and trade contains numerous statistics which point to increasing prosperity.

The author's main theme is Turkey's economic position, but he also studies social conditions, giving interesting information regarding such matters as education, emancipation of women, the law, welfare institutions, and the planning of towns on European lines. What he has to say about social reforms shows that rapid strides are being made towards a material and intellectual culture equal to that of the West.

M. Clerget has treated his subject with exemplary impartiality, which adds to the value of this little book of facts and figures. F. M. M.

SAND AND SEA IN ARABIA. By NORMAN LEWIS. *London: George Routledge and Sons*, 1938. $11\frac{1}{2} \times 8\frac{1}{2}$ *inches;* x+123 *pages; illustrations.* 15*s*

As the author confesses in his foreword, "This collection of photographs and superficial impressions of the South Arabian scene takes the place of a more ambitious book which was to have been written if permission could have been obtained to enter the Yemen." It deals with a short journey in the Aden hinterland and from Aden by an Arab sambuk through Bab el Mandeb and northwards along the eastern shores of the Red Sea to Jiddah. There are some interesting studies of Arab boatbuilding at Ma'ala, near Aden, and of the pearl fisheries near Kamaran, while the author's fellow passengers help to "give the atmosphere." A few illustrations of deserted Suakin are included at the end. The photographs are excellent and well reproduced. K. M.

AUS DEN EINSAMKEITEN IRANS: dritte Forschungsfahrt durch die Wüste Lut und Persisch-Baločistan mit einer Reise durch Süd-Afghanistan. By ALFONS GABRIEL. *Stuttgart: Strecker und Schröder*, 1939. $10\frac{1}{2} \times 7\frac{1}{2}$ *inches;* xvi+186 *pages; illustrations and maps. M.*9

This is the third book written by Dr. Gabriel to describe a desolate corner of Persia through which he and his wife recently made a risky journey. The immediate objective of the first part was to explore the "white spot" on the map, the southern part of the Dasht-i-Lut. An old route was reported to cross this desert from north to south and was deemed to be passable, since "it may be accepted as certain that the climate of Persia has not become worse in historical times." Seven days of exhausting camel travelling from Gerr-i-safid in the north enabled them to cross the waterless desert and reach the village of Keshit in the south-west. They found sand-dunes crowded along the south-eastern edge of the Dasht-i-Lut piled up to the enormous height of 220 metres above the silt floor. In the central part of the desert wind-eroded deposits of bedded silts form ridges running N.N.W.–S.S.E., which are known as the "Towns of Lut," separated by flats of desert likened to "streets," some of which are cluttered up with blown sand. The origin of the sand is attributed to dried-up deltas round the edge of the depression, Trinkler's explanation of the sand in the Takla Makan.

The second part of the book deals with a journey along the watershed between the Jaz Murian and the Dasht-i-Lut. It is a desolate stony region infested by robber bands from which the travellers appear to have had fortunate escapes. There is a settlement at Hudiyan in which the people may represent a residue of earlier inhabitants of eastern Persia who found refuge in this barren unattractive country from invaders. Before going on they climbed to the summit of the recent volcano Kuh-i-Bazman (3488 metres), which is known locally as Kuh-i-Zindeh. This was undertaken in May when the heat was great and travel was only possible either at night or in the early morning. Food is scarce and living on the country was precarious. The hardships accentuated fever, which was so bad that they were lucky to reach a motor road and get mechanical transport into Zahedan.

The third phase was a journey in June and July along the Khash road in Afghanistan from Kang to Dilaram, where they disbanded their animals and went to Qandahar and Quetta by road.

An account of the geographical results of their journey was published in the *Journal* for September 1938, and the maps from that paper illustrate this book; there are some good photographs and a few vivid pencil-sketches of landscape and natives. The book is a mine of botanical information. Dr. Gabriel's writing reflects the outlook of one who rejoices in a starlit sky and who is able to forget

the privations, perils, and irritations surrounding him. There is a careful index. The author has read widely and quotes ancient and modern writers with facility.

J. V. H.

TRENDS OF AGRICULTURE AND POPULATION IN THE GANGES valley: a study in agricultural economics. By BIRENDRANATH GANGULI. *London: Methuen and Co.*, 1938. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xviii+316 *pages; sketch-map.* 18*s*

In an area so well known and so fully studied as the Ganges valley it is difficult to say anything that is new except through the detailed field investigation of some particular aspect of the problem, which is essentially one of adjustment of the population to the geographical setting. Professor Ganguli has relied primarily for his material on published sources, especially on the Census Reports, Settlement Reports, and Gazetteers. He recognizes the fundamental differences in geographical conditions by dividing his book into three parts, dealing respectively with the upper Ganges valley, the middle Ganges valley, and the delta: the three major "natural regions" used by the Census. Each of these three parts is divided into four chapters: extension of cultivation, double-cropping, water supply, and crops—each considered in relation to density. The conclusions based on this elaborate analysis seem rather to labour the obvious: "the geographical distribution of population in the upper Gangetic plain depends essentially upon the facilities of agricultural water supply, and these are, again, determined by the meteorological conditions and the physical and chemical conditions of the soil." It is in the introduction that the author presents his general conclusions or expresses his own seemingly rigid viewpoint. On the grounds that increased efficiency in agriculture involves economy in man-power, he concludes that the most important consideration is extension of agriculture and that the ratio of cultivated area to total area is an index of both the scope for agricultural enterprise and the extent of such enterprise. This is but one example of the lack of vision and absence of penetrating analysis which run through the whole book.

L. D. S.

HIMALAYAN VILLAGE: an account of the Lepchas of Sikkim. By GEOFFREY GORER. With an introduction by J. H. HUTTON. *London: Michael Joseph, Ltd.*, 1938. $9\frac{1}{2} \times 6$ *inches;* 510 *pages; illustrations.* 25*s*

This book is an important contribution both to ethnography and to anthropological theory. As a field record it describes the life of the Lepcha community of Lingthem village, which was the subject of C. J. Morris's 'Living with Lepchas,' and deals with every phase of their culture, though not always very systematically. Most full and valuable is the author's treatment of kinship and marriage, and particularly his observations on the system of tolerated extra-marital intercourse, which is governed by rules of decorum and by specific prohibitions which guard against promiscuous competition between kinsfolk. The discussions of economics and religion are not so satisfactory, largely because of the author's failure to integrate the two; in fact he minimizes the part played in economic affairs by Lepcha religion which is "above all occupied with health" (p. 83). But one of the three Lepcha cults (that of the People of Mayel) is primarily concerned with crops, while fertility ritual enters into the other two, the Mun cult and lamaism; and his argument, as regards the latter, that "these rites take an insignificant place in the yearly sum of religious ceremonies" seems to depend on the fallacy of equating the amount or intensity of religious behaviour with its sociological importance.

The author is to be congratulated on the clear picture which he gives of the

conditions under which his research was carried out, and especially of his relations with the natives (pp. 249–54). He spent two months learning the language from detribalized Lepchas and only three in collecting the vast mass of material from the community studied; this may rouse the anthropologist's doubts as to how extensively native statements were "checked and counter-checked" (p. 31) and whether the majority of his generalizations are founded upon numerous detailed observations as he claims (pp. 436–7). He seems moreover to have placed too much reliance upon the readiness of people to reveal feelings which are condemned by their culture. Thus, since he demonstrates that "aggressiveness" is taboo among the Lepchas, it is certainly possible that antagonisms, feuds, and jealousies may have been as rigidly suppressed as would be the Lepchas' personal revelations or the conversation on pp. 261–2 in polite European society. Subject to these reservations however the work is admirably documented and special mention should be made of the valuable statistical material introduced incidentally throughout the text and systematically in the appendices; the biographical and psychological observations on individual personalities are also of value, though many readers will share Professor Hutton's scepticism (p. 26) on the correlation between the treatment of infants and adult behaviour, and may regard it as depending on a *post hoc ergo propter hoc* argument.

Theoretically this book raises more problems than it solves. It emphasizes the present-day conflict between those ethnographers who would rather remain silent on vital problems than carry their formulations beyond established fact, and those who rush in where scientists fear to tread. The latter attack problems of comparative human adjustment and happiness, stressing their practical bearing on the social conflicts, horrors, and miseries of the modern world; but they seek to solve them by the hasty generalizations and arrant subjectivism which at times vitiate even Gorer's admirable study, and particularly his final chapter on "Social evolution and aggression." The dilemma of the modern anthropologist—that it seems impossible to be at the same time both useful and scientific—is due to the failure to exploit to the full the comparative possibilities and heuristic resources of functionalism, the only discipline which justifies anthropology's claim to a place among the sciences. But in spite of his configurationist bias and his unnecessary exhumation and re-interment of Engels' 'Origin of the family,' Gorer's work offers promise of a dynamic, comparative, and scientific development in the study of human culture. R. P.

LHASA: the Holy City. By F. SPENCER CHAPMAN. *London: Chatto and Windus*, 1938. $9\frac{1}{2} \times 6$ *inches;* xiv + 342 *pages; illustrations and map.* 21*s*

In 1936 the British Government decided to send a friendly political mission to Lhasa under Mr. B. J. Gould, which the author accompanied in the capacity of private secretary. The Mission stayed in Lhasa for six months, from August to February 1937, and in this most interesting book Mr. Spencer Chapman gives the results of his observations and experiences while there and on the journey.

Mr. Chapman has previously made expeditions to Greenland, and to Iceland and Lapland, and in 1936 was a member of Marco Pallis's expedition to the Zemu glacier near Kangchenjunga. He thus comes with a fresh mind from other fields, and, as Sir Charles Bell remarks in the introduction, his statements and opinions are his own, which adds freshness of insight to his observations. Mr. Chapman is an experienced botanist and ornithologist, and throughout the book devotes special attention to these subjects. He is also an expert photographer, as is shown by the beautiful illustrations. The plates are excellent, especially the colour plates, and are the best pictures of Lhasa that have

appeared up to the present. The author also took films, both plain and in colour, and the showing of these was one of the most successful forms of entertaining their visitors in Lhasa.

As the object of the Mission was largely to continue friendly relations with the Tibetan Government, whose guests it was, the principal part of its activities lay in social intercourse and mutual visits and entertainments with the ministers and other government officials, and the book thus gives an intimate picture of the social and family life of the upper classes in Lhasa, and also of the New Year processions and celebrations.

It is interesting to note the progress on Western lines which has taken place, such as the introduction of electric light and power, which works except in the winter, when the water-power is frozen; and in the Mint, where coins are struck and notes printed on up-to-date electrically worked machinery from England. There is still however no idea of sanitation.

Of great interest is the author's description of the mausoleum of the late Dalai Lama and the structural alterations to the Potala necessitated by its inclusion in the building. This tomb exceeds in richness and magnificence even those of the previous Dalai Lamas. In many other cases also the author adds interesting details to previous descriptions.

In the introduction Sir Charles Bell reviews the political history of Tibet from the Younghusband Mission to the present time. There is a Botanical Appendix by Mr. C. E. C. Fischer, of the Kew Herbarium, on the plants collected. Although only four of these are new species, the collection is of great value as showing the further distribution of the plants. E. H. C. W.

AFFAIRS OF CHINA. By Sir Eric Teichman. *London: Methuen*, 1938. 9×5½ *inches; 312 pages; maps.* 12*s* 6*d*

BRAVE NEW CHINA. By Lady Hosie. *London: Hodder and Stoughton*, 1938. 9×5½ *inches;* xii+252 *pages; illustrations and sketch-map.* 12*s* 6*d*

These two books are profoundly different in approach to their common subject, yet their main conclusions are similar. The first work is that of an official writing in retirement, conveying accurate information and seeing to it that factors in situations are duly appraised. For this he is well fitted by years of service in the Legation at Peking, which gave him perspective in relation to the actions of the Powers during the last forty years. He has a practised hand in the setting forth of policies and the changes in them. Also he brings out the fact that the Legation often has a very different point of view from that of its nationals, *e.g.* the British merchants during the Nationalist Revolution. To him very naturally the Legation is always proved by events to have been wise and right.

The book starts with a series of chapters on the different Powers, and then goes on to discuss the major issues for the foreigners during the twentieth century: treaties and extra-territoriality, tariff reform, the Boxer Indemnity in its later phases, the Customs, Posts, and Salt Administration, the Treaty Ports, Shanghai, the coast and inland water trade. Then come chapters on the Chinese Government; the Communists and the Kuomintang; loans, railway concessions and consortium; army, navy, and aviation; currency, wireless, and mining enterprise. There is much for the earnest-minded inquirer, but with one marked defect: the foreigners and their interests are so much in the foreground. As the author says of the residents in the Legation Quarter in Peking in its palmy days: "to the majority . . . the Chinese hardly existed save as a background affording material for academic study and the collection of *objets d'art*." The result is that the perspective is wrong at times, as for instance in relation to what Lady Hosie calls "a morass of brigandage." It is not true that round

about 1920 all China was sunk in civil war and brigandage. Neither has justice been done to the Chinese gifts at local self-government.

On the whole the author is usefully outspoken, quite clearly enjoying his present opportunity. But now and again old habits of diplomatic reticence assert themselves. Thus he makes no mention (p. 153) of the consular action in Shanghai over the Mixed Court being entirely *ultra vires*. That action may have been warrantable temporarily to meet an emergency, but not on the permanent basis on which it was done. Then he must know, as the Lytton Commission did, that the Mukden clash in 1931 did not perhaps happen "by chance." He knows also that on the night of 9 January 1932, when the Shanghai War started, the Japanese marines did not just "advance to the positions assigned to them under the scheme of international defence": they took the entirely unprecedented step of going a mile into Chinese territory. So also the account of the far-reaching May 30 incident in Shanghai (1925) is not very satisfactory.

Apart from facts and figures this book has a considerable psychological interest: namely, the emancipation of the author's mind. One might almost say that two people wrote the book. One of them was the British official, always in his own mind "anxious to be just and fair, with due regard to British interests." The other was the rather cynical critic that modern *real-politik* produces, who is quite clear that the treaties were unequal, tariff restrictions unconscionable, and that no Power gives anything away just because it is right. The two minds have not coalesced, with results which in certain passages are very curious from an ethical point of view. There is in addition a third person who believes profoundly in truth speaking and fair and humane dealing; and the book would have been even more valuable if he had succeeded in taking control of the official and the cynic.

Lady Hosie went back to China in 1936 to renew old friendships and to see the changes which had come in the ten years since she had been away. The result is a series of impressions gained in different parts of the country from Canton in the south to Peiping in the north, and as far west as O-mei Shan on the borders of Tibet. What Lady Hosie saw had a profound effect on her, the more vividly realized because of the wholesale destruction since wrought by the Japanese. She was amazed at the speed and solidity of development. But it is people in whom her ardent soul rejoices, and it is individuals that we find most in her pages, portrayed vividly and affectionately, and so not always with the discrimination of cool judgment. If the reader will regard the book simply as a record of very personal experiences, he will learn much from it.

One or two statements are confusing. Middle schools are not "midway between high schools and universities" (p. 183): they are the high schools themselves. Who were the "Chinese Catholics with their French bishop . . . who were massacred about a century ago" (p. 40)? Is not this a confusion of events, with the Tientsin massacre of the 'eighties mainly in the author's mind? Nor can the negotiations in Tientsin between 1859 and 1862 be regarded as having nothing to do with missionaries and their enterprise. Both Catholic and Protestant plenipotentiaries very much had them in mind along with trade and other matters.

It is worth noting that both authors believe that the Chinese people will not become Communists unless the Japanese drive them to Russia. As for the outcome of that invasion, Lady Hosie's final words are: "The end is not yet." Sir Eric Teichman concludes: "If China's new-found unity will stand the strain, and if the Chinese continue to resist, no military victories will in the long run avail the Japanese."

E. R. H.

THE DEVELOPMENT OF JAPAN. By KENNETH SCOTT LATOURETTE. Fourth edition. *New York (and London): The Macmillan Co.*, 1938. 8×5 *inches;* xii+272 *pages; sketch-map.* 10*s* 6*d*

Although writing of unbiased history is never easy, and even though in the closing sections of this work Professor Latourette deals with contemporary events, his rigidly objective method has enabled him to produce a lucid and unprejudiced history of Japan down to the early part of 1938. First published in 1918 and now in its fourth edition, this book meets a widespread need, for there is hardly any section of the world's history that is less generally known than that of Japan. To examine in detail the main events which have served to create her present position would far exceed the compass of a review, but perhaps one of them may be emphasized: historically considered, the recent development of Japan is not a new thing, but the continuation of a process that was interrupted some three hundred years ago by an experiment in isolation and autarchy for which the religious quarrels of contemporary Europe were largely responsible. It is not too much to say that Japan's withdrawal from, and subsequent re-entry among, the nations of the world were among the major events in its history.

In such a dispassionate, straightforward work, supported by an array of sound authorities, there is little that calls for criticism, though perhaps the inclusion of Italy (p. 147) among the "parliamentary" nations may have been carried over from an earlier edition. E. H. de B.

## AFRICA

DESERT AND DELTA. By Major C. S. JARVIS. *London: John Murray*, 1938. 8½×5½ *inches;* viii+320 *pages; illustrations and sketch-map.* 10*s* 6*d*

Many who have enjoyed Major Jarvis's other volumes will welcome the appearance of his latest work telling of the life of an administrator among the peoples of the outskirts of Egypt. The Delta figures in the theme mainly in connection with an account of the political situation and of the vicissitudes of the central government with its ebulitions of students and schoolboys, concluding with an account of the farce of a general election. The greater part of the book deals with the desert, where he enjoyed working among the Arabs. Major Jarvis possesses a thorough understanding of the Arabs and their many failings: he tells us that if he had to live his life again, he would choose the job of administering them, for they have many sterling and lovable qualities, and he has been happier among them than with any other race. His was the task of adapting the laws of civilization, or even protecting the nomads from the incidence of such legislation, as when he went personally to the Minister of Finance about the taxation of the tobacco which they manage to grow in odd corners. After other arguments had failed he rolled a rough cigarette; one deep draught was enough, and the Arab had his tobacco free.

Though the book does not set out to describe them, there is much to be learnt from it about physical conditions in the desert. There is a most interesting account of the successful resuscitation of irrigation in the Gedeirat near the Palestine border of Sinai, where there were flourishing settlements in Roman times. When the work first started there only remained about half a dozen acres under irrigation. In due course, but after overcoming numerous difficulties, a large part of the valley was brought under cultivation and proved extremely fertile. Major Jarvis is a keen and expert gardener, and this was evidently a labour of love. The Arab with his camel and goat has destroyed nearly all the fertility in places which formerly supported thousands of inhabi-

tants, with carefully tended reservoirs and underground cisterns. There is no need to invoke climatic change : the difference is due to the habits of the people.

Major Jarvis writes words of warm appreciation of the hardworking and lovable fellah. Fishing is an important source of both food and income along the coasts of these desert regions, and we have accounts of both the personalities and their methods.

Besides several apt cartoons from current Egyptian periodicals, the book is illustrated by a number of excellent photographs. The outline-map is ample to show the positions of places described. G. W. G.

TREKS AND PALAVERS. By Captain R. R. OAKLEY. *London: Seeley, Service and Co.*, [1938]. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 300 *pages; illustrations and sketch-map.* 18*s*

Nigeria is still poorly represented in general literature, and Captain Oakley's book is a welcome addition. It is a pleasantly written and well-illustrated account of incidents in his career there as an administrative officer, with details of his dealings with backward tribes; his modesty obscures the many difficulties a lone white man with a tiny force has to face when dealing with large numbers of suspicious tribesmen on their home ground. The animals and birds in which Captain Oakley took a deep interest fill several chapters. The whole book displays a real enthusiasm for life in Nigeria, in spite of the anxiety that the author's war wounds must have caused him. It is a pity that works of this kind often use vernacular words where there are ordinary English equivalents. Its documentary value would be increased if some of the incidents and descriptions were to be dated: for example his description of Lagos, while true some years ago, is not entirely correct to-day. The author's sketch-map is not sufficiently detailed to show the smaller places mentioned and puts Hadejia much too far to the east; the English form of "T'Chad" might have been more suitable. There is an unusually full index. C. R. N.

THE NATIVE RACES OF AFRICA AND MADAGASCAR. A selection of passages from the notebooks of Sir JAMES GEORGE FRAZER. Edited by ROBERT ANGUS DOWNIE. (Anthologia anthropologica.) *London: Percy Lund Humphries and Co.*, 1938. $11 \times 8\frac{1}{2}$ *inches;* xii+578 *pages; maps and portrait.* 35*s*

This is the African raw material from which Sir James Frazer has constructed his many works. It is hoped that the raw material from other parts of the world will be published in further volumes. It consists of passages from books, mainly by early authorities, which record the customs and beliefs, chiefly those relating to religion and magic, of the native peoples of Africa and Madagascar. These excerpts were copied by Sir James Frazer during half a century of research into between forty and fifty quarto notebooks, and they are now published through the labour of Mr. R. A. Downie. They show the same courteous care with which Sir James Frazer has treated his authorities in his earlier writings. Their special value lies in the fact that very many of the passages quoted are from obscure sources: old journals, rare books, and books written in foreign languages. Together with the late Mr. E. Torday's 'African races' this volume forms a valuable collection of original sources for the study of African peoples. E. E. E-P.

AFRICAN ODYSSEY. By JOSEPH CRADD. *London: The Travel Book Club*, 1939. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 286 *pages; sketch-maps.* 12*s* 6*d*

Transport-riding and incidental exploits in Matabeleland (before and during the British conquest), Natal, and East Africa supply the trails which the author traverses again, nearly half a century after. Dates are rarely supplied, so that

as history the narrative cannot easily be assessed; yet there is no dearth of detail, a large proportion of which refers to raids and counter-raids, to the destruction of kraals in various acts of vengeance, and so on. The peaceful progress of South Africa in these modern days must seem a dull business to Mr. Cradd. In one who claims the experience of the pioneer, dependent on his rifle, a lack of special interest in the evolution of Bantu society is perhaps understandable, but he must know that the violence involved in imperial expansion is no longer regarded as the material for a saga in which pride can be felt. One of the most readable sections of the book is that which records the life and character of Lobengula, one-time paramount chief of the Matabele. W. F.

AFRICAN MAJESTY: a record of refuge at the court of the King of Bangangté in the French Cameroons. By F. CLEMENT C. EGERTON. *London: George Routledge and Sons*, 1938. 10×6 *inches;* xx+348 *pages; illustrations and sketch-maps.* 18*s*

There is a quality in this book which is very pleasing but which is not easy to define. One cannot say, for instance, that it is a travel book, though the author travelled to an out-of-the-way place in the French Cameroons where he stayed awhile and wrote down what he saw going on round about him. Nor can one describe the book as being purely ethnological, though it is mainly concerned with the life of the people amongst whom he was living. In many ways it is not unlike Brett Young's 'Portrait of a village,' only the portraits are not so clearly drawn; Mr. Egerton's book meanders along placidly in the same way and provides a background which, even if one does not know that part of Africa, one recognizes to be essentially African. The published work of the trained ethnologist is frequently concerned with facts, and it is difficult to visualize the background. Here the converse is not quite the case because the author has done much more than paint a background; his characters are alive and very real persons. In some instances more detail would have been welcomed, but the broad outlines of the general sociology of the people are there; and even if the work is not highly scientific, it is certainly interesting and instructive.

E. B. H.

## NORTH AMERICA

HISTORY OF PRAIRIE SETTLEMENT. By ARTHUR S. MORTON. "Dominion lands" policy. By CHESTER MARTIN. (Canadian Frontiers of Settlement. Edited by W. A. MACKINTOSH and W. L. G. JOERG. Vol. II.) *Toronto: The Macmillan Co.*, 1938. 10×6½ *inches;* xviii+572 *pages; diagrams and maps.* $4.50

In the present volume of this series the history of prairie settlement and the history of "Dominion lands" policy form two independent, though closely related, works, the first by Professor Morton, of Saskatchewan, and the second by Professor Chester Martin, of Toronto. Logically the "Dominion lands" policy is prior to the settlement of the prairie, inasmuch as, apart from the disappointing Red River settlement of Lord Selkirk, the permanent peopling of the prairies could not begin until the Dominion of Canada had taken over Rupert's Land from the Hudson's Bay Company in 1870. The Dominion Government, faced with the early prospect of the pre-emption of the west by the United States (as Oregon had already been pre-empted), was convinced that only railways and population, in that order, could save the west for Canada. Capital for railways could be attracted only by generous grants of land, which were expected to cover much of the costs of construction, and pioneer settlers would be drawn by the magnet of the free homestead once there was railway

transport. The Dominion Government therefore retained in its own hands all the lands that came to it from the Hudson's Bay Company, with the trifling exception of the areas secured to the Red River settlers, the half-breeds, and the missions. These were the "Dominion lands," differentiating the new provinces of the prairies from the provinces of the east and of British Columbia, where Crown lands were in the possession of the provinces and not of the Dominion. For the settler the Dominion policy, so long as suitable land was available, was the provision of a free homestead of 160 acres, but railway grant lands, education endowment lands, and lands reserved for the Hudson's Bay Company amounted to about half the total potential farm lands, and all of these were disposed of by sale. It may be suggested that in so far as land for purchase was available alongside the free homesteads it contributed not a little to the increase in size of the average farm above the quarter-section free homestead, a very necessary trend in all except the more humid areas of the prairies. At every point in a programme of attracting railways and population by grants of land there was precedent from the United States, and the Dominion did not entirely escape the abuses that had already brought the programme into disrepute across the border. Professor Martin however points out the fundamental differences between Canadian and American backgrounds and procedure, and on balance sums up favourably for the Dominion policy and its administration. The land was used as a basis for new farms and homes, not simply as a source of revenue, and therein lies the justification for Dominion rather than provincial control. It should be added that in 1930, when the purposes of the Dominion had been largely fulfilled, the remainder of the public land was handed over to the three prairie provinces, which were compensated for the deprivation since their formation of the land alienated by the Dominion Government.

Professor Martin's history forms the legal, constitutional, and administrative background to these developments, and might profitably be read first. Apart from the first two chapters, which bring the story of the Red River settlement up to the creation of the Province of Manitoba in 1870, Professor Morton's work is divided on the basis of census decades. He is concerned not merely with growth of population, but traces the struggles to evolve farming practices in tune with the short growing season and the light and irregular precipitation. The contribution of the railways, not merely as transporters of wheat, but also as large markets for labour and produce; the various strains and nationalities of the incoming settlers, with special mention of the value of the Americans, who usually had capital and previous experience of farming on the drier prairies; the origins and relative values of the new wheats from Red Fife to Reward; and the growth of livestock industries, especially since the War and with particular reference to the poultry-fattening industry of Saskatchewan, all receive thorough and fresh treatment.

Each part is indexed separately and each is well supplied with maps, some of which have appeared in previous volumes. The geographer will probably find Professor Morton more immediately useful to his special work than Professor Chester Martin, but both parts are a worthy contribution to the series.

R. O. B.

I WAS THERE. By EDITH TYRRELL. *Toronto: The Ryerson Press*, 1938. 8×5½ *inches;* xii+132 *pages; illustrations.* $2

Mary Edith Carey, the daughter of a Baptist minister, was born at St. John, New Brunswick. In 1894 she married J. B. Tyrrell, son of William Tyrrell of Weston, whose biography was reviewed in the *Journal* for May 1938. J. B. Tyrrell was a member of the Canadian Geological Survey who carried out

valuable exploration work in the Barren Lands, for which he received, in 1896, the Back Grant from this Society. Later he left the Geological Survey to seek gold in the Klondike, and on two occasions Mrs. Tyrrell joined her husband at Dawson City, where she lived for some time. Her accounts of the journey there and of the general conditions in Dawson City during 1899 and 1903 are perhaps the most valuable part of this story of a happy and not uneventful life.

T. S. W.

JOURNAL OF OCCURRENCES IN THE ATHABASCA DEPARTMENT by George Simpson, 1820 and 1821, and Report. Edited by E. E. RICH. Introduction by CHESTER MARTIN. (The Publications of the Hudson's Bay Record Society. Vol. I.) *London: (Published by the Champlain Society for) the Hudson's Bay Record Society*, 1938. *Also Toronto* (The Publications of the Champlain Society: Hudson's Bay Company Series, I), 1938. 9½×6½ *inches;* lx+498 *pages; portrait and maps*

This is the first volume of Hudson's Bay records, published under the joint auspices of the Hudson's Bay Company and the Champlain Society of Canada.

Simpson's Athabasca Journal throws light upon the last two years of rivalry between the Hudson's Bay and North West companies, for the war with the Nor' Westers is its central theme. In 1820 these rival companies of the colonial commercial empire faced disaster as a result of their competition. Though in 1815 a settlement had been discussed, the negotiations had ended in deadlock, and it was not until 1821 that a coalition brought the feud between the rival fur companies to a close. The value of the Journal rests particularly on the light it sheds on an important turning-point in Canadian history, and little on its purely technical accounts. Simpson's records were kept however with the expectation that they would be read by Hudson's Bay Company officials, as is evident from his statement on p. 359. It is quite possible consequently that events were sometimes interpreted in his own favour, though he intended to give "an accurate and unbiassed report of the principal occurrences that may take place within my observation." The report throughout reveals clearly his adroit management, his iron discipline, and his intense thrift.

This volume gives the complete text of Simpson's Journal and his report on the Athabaska district. It is transcribed with textual accuracy and its value is enhanced by the explanatory notes throughout the text. In addition there are two comprehensive appendixes—one giving details of posts and districts, the other biographical. Professor Martin's excellent introduction describes the decade of conflict, the "war" in the Athabaska district, and the coalition. It is regrettable however that the index has so few subdivisions, for it is difficult to find a particular reference among fifty alternatives. The departure from the chronological method of publishing the Hudson's Bay Company records seems to be offset by the importance and excellence of this present volume. The editor, too, with an eye to the future, has wisely prepared the appendixes so as to facilitate references in succeeding volumes.

H. J. C.

## CENTRAL AND SOUTH AMERICA

THE SUGAR ECONOMY OF PUERTO RICO. By ARTHUR D. GAYER, PAUL T. HOMAN, EARLE K. JAMES. *New York: Columbia University Press (London: Oxford University Press)*, 1938. 9½×6 *inches;* xviii+326 *pages; sketch-map.* 18*s* 6*d*

Puerto Rico, which Columbus called San Juan when he discovered the island in 1493, is one of the most densely populated regions of the tropics. Its density

of 500 per square mile, or 1500 per square mile of cultivated land, vies with Java or even with industrialized areas of Europe. Yet practically all this population is agricultural, for industries, except in relation to sugar refinery, are of little importance. Most of the Puerto Ricans are of Spanish descent although about a quarter are classed as coloured, and there are now some two thousand Americans. Most of the island is verdant and productive; its climate is generally warm and sunny; yet things are far from well in Puerto Rico, and at the root of all the trouble appears to be unemployment leading to a low standard of living. Since America's rule began in 1898, sugar has been the chief crop and now covers over a quarter of the island. Both acreage and yield have much increased. Coffee is stationary and has been much injured by hurricanes. Other crops, including food crops, are of minor importance and a great amount of food has to be imported. America has done much to improve sanitation, public works, education, transport, etc., but does not appear to have alleviated the social and economic friction that is rife. The three authors (two economists and an historian) of this book make an objective study of the sugar industry and its bearing on economic and social problems. Much of the book is economic rather than geographical, but all of it is a valuable contribution to the problems of other West Indian islands. The authors' reluctance to draw definite conclusions and to make positive suggestions are signs of well-balanced judgment.

R. N. R. B.

UTOPIA IN URUGUAY: chapters in the economic history of Uruguay. By SIMON G. HANSON. *New York [and London]: Oxford University Press*, 1938. 9×5½ *inches;* viii+262 *pages.* 15*s*

This book adds to the growing number of economic studies of Latin America published lately in the United States. Uruguay is the smallest South American State, but it is almost without waste land, has a temperate climate, well-watered soil, and a coast-line and port covering the entrance to the river Plate. No South American country has so great a share of European stock; but until 1903 internal dissensions had resulted in a low level of literacy, cessation of immigration, and low standards of working life.

Having outlined the background, Mr. Hanson studies in more detail Uruguay's social and economic evolution from 1904 to 1929. It was due to one man, José Batlle y Ordóñez, socialist, journalist, and twice President. Batlle's reforms may have lagged behind those of western Europe or North America, but they were equally in advance of South American opinion, not to mention practice. His programme was opposed by conservatives and especially by the great landowners, whose pastoral products provided perforce Batlle's financial basis. His dictum "Everything that the will of the people justifies is within the law" was used to make of the Republic an experimental social laboratory, and it is to the outcome of the experiment that the author invites our attention.

Batlle's first presidency covered a preparatory period. When he again attained office in 1911 he launched a series of reforms with few parallels: strict enforcement of the secret ballot; State monopoly of insurance, light, and power; for labour, an eight-hour day with the "semana inglesa," *e.g.* free Sunday and a Saturday half-holiday; workmen's compensation; old-age pensions; universal free education; the separation of Church and State; a State central bank and State mortgage bank; State railroads and a system of highways whose competition compelled drastic reductions of rates on the foreign-owned railroads; control of Montevideo port, with State fishery as a side-line, and a State packing-house with retail monopoly in and round the capital. These were the main issues, and all now figure on the statute book.

Uruguay's capacity to digest and implement this mass of social legislation depended on budgets of increasing volume, and these called in turn for an expansion of exports and imports, on which the revenue largely depends. The imports were necessarily paid for by exports of pastoral products, which in 1929 suffered a catastrophic drop in price. Owing to an inelastic consumer demand for such products overseas, the drop in prices could not be compensated by increased output, and by 1933 Batlle was forced to resign by the party of financial retrenchment and reform. Yet though many of the measures he instituted made halting or unequal progress, others, like the State mortgage bank and the State power and light monopoly, not only proved their value to the country but the capacity of Uruguayans to run them efficiently. Possible over-expenditure in State public utilities was defended on the grounds that such drawbacks mark only early beginnings and that the wasted funds, if any, stayed in the country; whereas profits from the more efficient foreign-controlled enterprises went abroad. The foreign investor has retorted by abstaining from Uruguayan investments, and lately State loans have been increasingly internal.

The author renders a service by his thorough study of Uruguay's statistics, which are by no means so up to date as its legislation. His conclusions are based not only on the official sources but upon independent computations by local experts and by the many helpers to whom tribute is paid in the foreword. Not the least value of his work is that students may safely accept the statistical datum lines Mr. Hanson has drawn, without the laborious research into earlier records which underlies his figures and his conclusions. W. S. B.

## AUSTRALASIA AND PACIFIC

THE PASSING OF THE ABORIGINES: a lifetime spent among the natives of Australia. By DAISY BATES. *London: John Murray*, 1938. 9×5½ *inches;* xviii+258 *pages; illustrations and map.* 10s 6d

In 'The passing of the Aborigines' Mrs. Daisy Bates has given a most interesting and pathetic account of her life for thirty-five years among the broken-down tribes of Western Australia. For long stretches of time she lived in camps with strays from widely separated districts; the blind, the diseased, the hopeless, and the dying gathered round her to be fed and to be comforted by her ministrations. She devoted herself and her means to ameliorating the condition of the people whose land and subsistence had been taken away by white settlers. She herself had to undergo hardship and privations aggravated by great heat and drought. At various times the West Australian Government has tried experiments which were sincerely intended to improve certain conditions; one of these was an isolation hospital on Dorré and Bernier Islands, Shark Bay, which cost thousands of pounds. Mrs. Bates shows how this experiment failed and how "the benefits devised by the white people and the endeavours to lighten their pain were only so much the greater aggravation of their exile. . . . Rottnest Island Native Prison was only another tragic mistake of the early colonists in dealing with the original inhabitants of a country so new and strange to them." For many years the conscience of Australia has "been slowly but surely awakening to the tremendous human problem of the Aborigines throughout the continent in the rapid dwindling of the native groups in all settled areas and the inevitable conflict as colonization extended." Many of the difficulties of this problem are alluded to in this book, and some ways of solving them are indicated. Anthropological students look forward to the pub-

lication of the mass of material accumulated by Mrs. Bates from numerous tribes which are now actually or practically extinct. There should be invaluable information about social organization, ceremonial life, and legendary lore of which the present volume can give only a meagre hansel. A. C. H.

## POLAR REGIONS

CHARCOT OF THE ANTARCTIC. By MARTHE OULIÉ. *London: John Murray*, 1938. 9×5½ *inches;* xvi+236 *pages; illustrations and maps.* 12*s* 6*d*

JEAN-BAPTISTE CHARCOT, 1867–1936 (Bulletin du Yacht Club de France. Numéro de Noël 1936). *Paris* (1937). 11×7½ *inches;* 332 *pages; illustrations and maps.* 80*fr.*

The life of Jean-Baptiste Charcot is an example of how the national enthusiasm and romanticism of the French can turn cold hardship into pleasurable adventure. "He leaves on a cruise as if it were a crusade," a friend once said of him; and the same was true of his expeditions. They were a mixture of essential carefulness and irresistible impetuosity, as he himself was a disciple both of science and Jules Verne: he was a scientific buccaneer.

He became a doctor of medicine chiefly, if not entirely, to please his father, the great neurologist. But from his earliest years he had longed for more physically dangerous adventure. In his young manhood, he built a 10-ton yacht which he named *Pourquoi Pas?* and issued a challenge (writes Mlle. Oulié) to all other yachts, foreign and French, between 10 and 20 tons, to a long-distance race. Charcot's first exploratory voyage to Jan Mayen was in the *Rose Marine*, and his second ship, which took him to the Antarctic, was the *Français*. It was only on his third expedition that he returned to the name *Pourquoi Pas?* and seemed to prosper from it. On his first expedition his reaction to The Faroes is worth quoting as showing how the romantic in him could be more expressive than the scientist when confronted by masses of storm-washed basalt: "These vast shattered pyramids seem to hold the sky. . . . Between these pyramids, the fjords; some in the west, red as a glowing furnace, lit by the setting sun, others a steely blue, lit by the rising moon. . . ."

His second expedition was planned to search for Nordenskjöld in the Antarctic. Charcot had jumped at the opportunity of going south where there was much more original work to be done than in the Arctic. On this voyage, and on his subsequent expedition in the fourth and most famous *Pourquoi Pas?*—a three-masted barque of 800 tons—he carried out a great deal of valuable work along the Graham Land coast. Admiral Sir William Goodenough, in his intro duction to Mlle. Oulié's book, quotes a member of the recent British Graham Land Expedition as saying, "We found Charcot's maps remarkably good considering that most of them were based on running surveys from the ship. There were no outstanding errors of the type that were common in Antarctic maps at the beginning of this century, for he always carefully distinguished between what he had actually seen and what he surmised." This was his most important expedition, but his fame and popularity continued to grow; he was never idle, and was invariably charming and helpful to all with whom he came in contact. After the Great War he made a number of northern voyages in the *Pourquoi Pas?* before she was lost off the coast of Iceland with all hands but one.

Mlle. Oulié's book is personal and impetuous, often vivid and sometimes extremely moving. Dr. Charcot was as great a personality as he was a traveller, and this book is valuable for the intimate portrait that it gives of him. The handsome volume published by the Yacht Club de France is more thorough and

precise, but since it is the work of a number of different pens it cannot rank as a biography. It provides details about Dr. Charcot's various ships, his voyages and scientific work. There is a chapter by Captain Ejnar Mikkelsen on Dr. Charcot in Greenland and a welcome assurance from Vice-Admiral Durand-Viel that the *Pourquoi Pas?* was entirely sound at the time of her last voyage, and that her shipwreck was due in no way whatever either to faulty navigation or to structural weakness. The two books are therefore complementary, and any one interested in studying the life of a great polar gentleman would be well advised to read them in conjunction. J. M. S.

## PHYSICAL AND BIOLOGICAL GEOGRAPHY

HANDBUCH DER KLIMATOLOGIE. Edited by W. KÖPPEN and R. GEIGER. Band IV, Teil T. Klimakunde der Südsee-Inseln. By G. SCHOTT. 114 *pages*. Band IV, Teil U. Klimakunde der Antarktis. By W. MEINARDUS. iv+134 *pages*. *Berlin: Borntraeger*, 1938. $10\frac{1}{2} \times 7$ *inches; diagrams and maps*. *M*.24.90

These two parts of the 'Handbuch der Klimatologie' cover very large areas for which however only scattered data are available. Professor Schott deals with the South Sea Islands, a historical geographical term which includes all the islands of the Pacific from lat. 28° N. to 29° S., and Professor Meinardus discusses the Antarctic continent with its neighbouring seas and islands. Both areas are of very great interest, and present many meteorological problems.

The South Seas include four main areas, defined by the prevailing winds: namely, the north-east trades, the "Doldrums," the south-east trades, and the transition region to the southern westerlies. The meteorology of the trade-wind regions is comparatively simple, the main point of interest being the distribution of orographic rainfall over the mountainous islands in the path of the steady moist wind; the peaks of Hawaii for example are among the wettest parts of the earth, while the lee shores are almost desert. The equatorial zone on the other hand is very complex, in both its winds and its rainfall. One would expect the meeting-place of the trade winds to be a region of ascending air and heavy precipitation, but the islands within a few degrees of the equator actually suffer from a shortage of water, and may be rainless for months at a time. This surprising result is probably due mainly to the fact that the surface of the sea is about a degree cooler than the air above it. This same difference is the cause of the intense aridity of Peru and northern Chile, and in both areas occasional wandering warm currents cause a complete temporary change of climate. A few degrees north, away from the influence of the cool current, we pass suddenly into a region of variable winds and violent rains. The modern ideas on fronts have recently been applied to this interesting region, but aerological soundings will be required before the structure of the atmosphere is fully understood.

In the Antarctic systematic meteorological exploration of the coasts and islands barely covers the present century, while apart from a few sledge journeys the interior is almost unknown. The various Antarctic expeditions have however sufficed to reveal the play of natural forces on a gigantic scale. Best known are the outflows of cold air which reach their greatest intensity at Cape Denison, probably the windiest region on the earth, where the winds have an average velocity of more than 40 miles an hour and amply justify Sir Douglas Mawson's name for Adélie Land: "The home of the blizzard." Other questions discussed are the amount and origin of the snowfall, the south polar front, the

source of energy for the numerous storms, and the variations of temperature, which are analysed in detail. A beginning has been made with the study of the upper air conditions by means of pilot balloon observations, cloud movements, and the smoke of Mount Erebus, which is high enough to project well beyond the local conditions of the surface.

This part of the 'Handbuch' maintains the standard of earlier sections in the charts, the numerous and complete tables, and the exhaustive bibliographies, that for the Antarctic occupying five pages. Both sections will be of very great interest and value to geographers. C. E. P. B.

DIE ENTSTEHUNG DES LEBENS DURCH STETIGE SCHÖPFUNG. By IGNAZ LICHTIG. *Amsterdam: Noord-Hollandsche Uitgevers Maatschappij*, 1938. 10½×7 *inches;* xx+372 *pages; diagrams. Gldn.*6

The origin of life remains one of the mysteries of the universe, and science has hitherto been able to throw little light upon it. It is generally assumed however that, whatever the nature of the process, it took place at some remote period of the earth's history under conditions that have long since ceased to exist, though this assumption has indeed been questioned from time to time. The controversy over "spontaneous generation" in the third quarter of last century ended in the discomfiture of the supporters of "abiogenesis," but in recent years the discovery of ultramicroscopic viruses has opened a fresh field for the speculations of those who believe that life may be continually beginning afresh under conditions that preclude the possibility of direct observation.

This book is written in support of what the author terms the Theory of Continuity, according to which primordial organisms are continually appearing in many places at the present time and have been doing so ever since life first appeared on the earth. These primitive forms have been continuously evolving under the same laws and following the same course and therefore producing identical organisms at different points of the earth's surface and at different periods of its history. The author examines at some length the evidence afforded by morphology, embryology, palaeontology, and so forth, and has no difficulty in showing that each of these departments of biological knowledge offers many problems, still largely unsolved, on any theory of monophyletic evolution.

Geographers will be interested to see how Dr. Lichtig deals with the problems of geographical distribution; it was the facts of geographical and geological distribution that first turned Darwin's thoughts to the problem of Evolution. Lichtig devotes a chapter to "the biogeographical argument," and has collected a long series of instances where the present-day distribution of plants and animals has not yet been convincingly explained. Cases of discontinuous distribution are discussed at length, and it is argued that the various land-bridges that have been thrown across the great oceans by different writers cannot possibly have existed. Wegener's theory of drifting continents fares no better, and the arguments brought against it are given full weight. Therefore, says Lichtig, we are forced to fall back on the theory of polyphyletic and polytopic evolution.

An evident feature of this theory is that, so long as details are avoided, it is capable of explaining anything. For example, Lichtig mentions the tapirs, whose occurrence in Central and South America and in the far-distant Malay area forms one of the classical examples of discontinuous distribution among animals. He leaves it to be inferred that the American and Malayan tapirs have been independently evolved, presumably from primordial Protozoan ancestors. Why no tapirs have been evolved anywhere else he does not tell us.

Biologists and palaeontologists are aware that there are many instances of parallel or even convergent evolution. It was even suggested long ago (although Lichtig does not mention it) that the American and Malayan tapirs may have acquired some of their common characters independently. To suggest that all their resemblances have so arisen is absurd. On this theory the facts of geographical distribution become as meaningless as they were under the doctrine of special creation.

Lichtig's book may have some value to those who need to be reminded that all our difficulties are not solved by the magic word "Evolution." As a contribution to biological or biogeographical theory it is negligible. W. T. C.

## CARTOGRAPHY

MEYERS GROSSER HAUSATLAS. Herausgegeben von DR. EDGAR LEHMANN. *Leipzig: Bibliographisches Institut A.G.*, 1938. 17×12 *inches;* 32+96 (*maps*)+140 (*index*) *pages. RM.*17.50

This work consists of three parts, a geographical introduction, the atlas proper, and an index containing about 100,000 names. The introduction is clearly printed in Roman type, and is accompanied by many maps in colour. Its purpose is apparently to deal in outline with the whole subject of geography. The pages on physical geography make no attempt to coordinate the various branches and are little more than commentaries on the accompanying maps of rainfall, temperature, etc., and the conception of regional geography does not emerge. The sculpture of the earth's surface is dealt with in a few lines on the formation of mountains and the erosive powers of water. More attention is given to the spread of European culture and the distribution of economic resources. There is a series of historical sketch-maps which interpret European history in the light of a particular political theory.

The atlas sheets, including more than 200 maps, are clearly printed in colour, though the relief in brown hachures and the occasional crowding of names detract from their appearance. Where layer colouring has been used the effect is pleasanter, though some of the browns are harsh. The atlas having been designed for the German public, the scales used vary with German interest in the regions portrayed. Germany and neighbouring countries are on a scale of 1/1,400,000, and areas of special interest on scales as large as 1/250,000. These are followed by Italy and Italian territories in Africa, France, and the western war areas, and the Mediterranean. The former German colonies also receive special attention.

In the index the various forms of place-names are entered separately, though German forms are given preference on the maps. On the smaller maps German forms alone appear. British India appears in the forms "Ostindien" and "Vorder Indien": the first was formerly applied by German geographers to the East Indian archipelago. The unusual form "Mandschutikuo" also appears in place of Manchukuo, and inner Mongolia is given the name "Mongolikuo." G. R. C.

## ECONOMIC AND HISTORICAL GEOGRAPHY

VOYAGE EN ORIENT DU ROI ERIK EJEGOD ET SA MORT À Paphos. By ARNO FELLMAN. *Helsinki: Librairie Académique*, 1938. 9½×6½ *inches;* 198 *pages; illustrations and maps*

We know little about King Erik Ejegod (the Ever Good) of Denmark except what can be gleaned from Saxo Grammaticus's 'Gesta Danorum,' the Icelandic poem "Eiriksdrapa," and the 'Knytlinga Saga.' He ruled admirably during his

short reign (*c.* 1095–1103), and died on Paphos before he could carry out his vow to visit the Holy Land and expiate a murder committed in hot blood.

Herr Fellmann has his own way of telling the story of Erik. He has used the available sources, but in the greater part of this book the protagonist is merely a lay figure round whom the author has written a number of chapters and dissertations on cognate subjects, richly illustrated by photographs and reproductions of early documents and maps found in the archives of a dozen countries. There are descriptions of the life and methods of navigation of the Vikings, of the history of Gotland (where Erik landed on his way to Jerusalem), of the scenery and history of southern Finland (the author's native land), the land route of the Scandinavians by Novgorod and Kiev to Constantinople, the history of the Byzantine Empire and its state in 1108, and the scenery and antiquities of Paphos as celebrated by Homer and later writers.

The ordinary reader will find this book too packed with miscellaneous extracts from all sorts of old works to be able to follow King Erik in his wanderings with much interest. The student of Scandinavian history will find nothing in the text that is new to him, but he will like the excellent photographs and be grateful for the many useful reproductions of rare maps, such as those by Al-Idrisi, Dati ("La Sfera"), Claudius Clavus, Gerritszoon, Adrian Veen, L. Benedickt ("Søkartet offuer Oster oc Vester Søen," 1568), and others. The author has printed a large number of copies of this work for presentation, not for sale. E. L.

A HAND THROUGH TIME: memories—romantic and geological; studies in the arts and religion; and the grounds of confidence in immortality. By EDWARD GREENLY. *London: Thomas Murby and Co.*, 1938. Two volumes. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xvi+378 *pages;* viii+379–774 *pages; illustrations and maps.* 18*s*

The title of this at first sight strange book is taken from Tennyson's "In Memoriam," a poem which was clearly a source of inspiration to the author when he sought solace in recording his reminiscences. Dr. Greenly is a distinguished geologist, and a considerable portion of this work is a narrative of experiences, largely shared by his wife, first between 1889 and 1895 as a Geological Survey officer in the north-west Highlands, and subsequently as an unofficial worker in Anglesey, upon which island he produced a memoir which in 1919 was published by the Survey. At the present time Dr. Greenly at an advanced age is continuing research on the Carnarvonshire side of Menai Strait. Among character sketches of celebrated geologists with whom the author worked those of the two Scotsmen Benjamin Peach and John Horne, names inseparably associated with Highland tectonics, are of particular interest. In the chapter on "Two crises in the history of geology" it is indicated that Horne's originality, somewhat overshadowed by the brilliance of Peach, has not been fully recognized; that it was Horne rather than Peach who was the first to recognize the existence of thrust-planes in the Highlands, formerly known as reversed faults, and who took the initiative in making a determined stand against the continued acceptance of Murchison's erroneous views of upward stratigraphical succession in that area. Dr. Greenly shows throughout keen sensibility to natural beauty. He tells us that the wild beauty, the bleakness and the solitude of the "savage Highlands" made a strong appeal to his imagination, and certainly the "memories, romantic and geological," will supply the local colour not to be found in the more prosaic Survey memoirs. L. C. W. B.

## GENERAL

GEOGRAPHY FOR TO-DAY. Book I. At home and abroad (xii + 244 *pages*). Book II. The southern continents: Australia and New Zealand (viii + 118 *pages*); South America (viii + 109–236 *pages*); Africa (x + 231–388 *pages*). Prepared by a committee. Editors: L. DUDLEY STAMP and L. S. SUGGATE. *London: Longmans, Green and Co.*, 1937. $7\frac{1}{2} \times 5$ *inches; illustrations and maps. Book I* 2*s* 9*d*; *Book II* 4*s* (*published in three parts in* 1938: 2*s*, 2*s*, *and* 2*s* 3*d*)

These are the first two of a series of four text-books, designed to serve as a basis for a progressive course in geography leading up to the School Certificate examination. The series has been drawn up by a committee of experienced teachers, and in the selection and arrangement of material bears the marks of careful planning.

The approach is essentially "human," the relationship of the region to the lives of its inhabitants appearing throughout as the central theme. The first book begins with a description of representative areas of contrasted types in the British Isles. A chapter dealing with ports and trade links the home country with the second part, "Environments abroad," which is an attractive presentation of the concept of natural regions, in the form of descriptive accounts of life in different environments.

The second book, which is available as a single volume or in three separate parts, deals with the southern continents. In each case the continent is introduced by a chapter on discovery and exploration, which it is refreshing to find treated in its geographical aspects, and not simply as an interpolation of history. The regional treatment follows, and then a general summary. An especially commendable feature is a final chapter linking up the southern continents in a brief, well-illustrated consideration of similarities and differences in the environments and economic development.

One is throughout impressed by the judgment shown in the relative emphasis placed on different aspects of geography. The text is both sound and interesting, and its value is enhanced by the illustrations. The plates, far from appearing merely to relieve pages of letterpress, are made an integral part of the regional descriptions. The maps and diagrams are also well chosen to emphasize or supplement the material available in atlases, and are well produced. The various population density maps however might have been made more easily comparable, and the printing of the dot-map of the population of Australia gives some wrong impressions in detail. Finally, teachers will appreciate the inclusion of exercises upon each chapter, "framed with a view to the pupil using the text and an atlas as well as to providing for adequate practice in drawing sketch-maps." A. E. S.

PRINCIPLES OF GENERAL GEOGRAPHY. By DEWAN BAHADUR H. L. KAJI. *Bombay and London: Oxford University Press*, 1938. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* viii + 356 *pages; illustrations and maps. Rs.*3/8

Until recently the study of geography in Indian universities has been sadly neglected. The institution of an Honours school at Calcutta, a strong department at Aligarh, the improvement of status at Madras, and a greater interest in Bombay and elsewhere are naturally coincident with the rise of Indian geographers prepared to deal monographically with sections of their country, or generally with varied aspects of modern geography, but from an Indian standpoint. Professor Kaji's book belongs to this second category; he is Professor of Geography at Sydenham College, Bombay, and although his work covers well-trodden ground his standard of comparison is India throughout. Thus his consideration of religious ideals in relation to their geographical

background (pp. 219–37) is both unusual and fascinating. He is less happy in his final chapter on the "Progress and problems of countries," where India is dismissed in five pages. Nevertheless there is a keen appreciation of essentials, and the book is a landmark in Indian geography. L. D. S.

ATLANTIC CIRCLE. By Lord MOYNE. *London: Blackie and Son*, 1938. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xii + 202 *pages; illustrations* (*by Lady Broughton*) *and route-chart.* 18*s*

Lord Moyne's new volume contains an account of his cruise of 1937 to a number of out-of-the-way and interesting spots within the limits of the northern half of the Atlantic. His object in making such voyages is not merely pleasure but the advancement of knowledge. His own tastes are chiefly anthropological, and his visit to Greenland was to examine the East Greenland Eskimo, a practically pure-blooded race, since those on the west coast of Greenland are now so much contaminated through Danish and other European intermarriages that there are practically no pure-blooded individuals left. Lord Moyne is also much interested in marine biology; he was fortunate enough to secure the services of Mr. John Coleman, a member of the Barrier Reef Expedition, to take charge of the marine investigations in both shallow and deep-sea waters. Some of the collections have recently been exhibited in the Natural History Museum, and a chapter at the end of the book is devoted to them.

Lord Moyne's yacht *Rosaura* was not a very satisfactory vessel for ice work, and his visit to Angmagssalik was an anxious one, especially for those responsible for the navigation of the ship. After only a few days' stay they barely escaped being frozen into the fjord for the next six months, and only at the expense of a broken propeller.

After Greenland it must have been a relief to visit some of the less well known islands of the West Indies such as Hayti, the Caymans, and the Swan islands. The latter group consists of two islands, an eastern and a western; the former alone is inhabited, and by a small party of Cayman islanders in charge of a coconut plantation. Here the political situation is most anomalous, as the islands are claimed by Great Britain, the United States, and the Republic of Honduras. No administration exists, and the Cayman islanders have to manage for themselves. There exists on this island the hutia or capromys, a curious guinea-pig-like rodent of which only some four species are known and which is otherwise restricted to Cuba and Jamaica, where it is now nearly extinct. Lord Moyne secured a dozen examples alive and brought some of them safely back to England.

Off the north coast of Honduras lie a chain of islands known as the Bay Islands containing a mixed population of English sympathies but now under Honduran rule. Here were found enormous quantities of pottery, figures, whistles, jars, and other objects which appear to have been derived from various pre-Columbian American cultures in Mexico and Central America. A large collection of these objects was made and has since been presented to the British and other museums. After visiting a number of ports along the north coast of South America the Atlantic was crossed to Gambia and Dakar in West Africa, where an accident to one of the propellers caused a long delay; some of the party went home across the Sahara in a motor bus, while the rest of the party with the livestock and collections returned to Southampton by sea.

No one can fail to be interested in Lord Moyne's account of this fascinating cruise, in which travel adventures, ethnology, antiquities, and natural history are all most skilfully intermixed, while the eighty illustrations reproduced from Lady Broughton's photographs are beyond all praise and are an added charm to the volume. W. L. S.

# THE MONTHLY RECORD

## AWARD OF THE GEOGRAPHICAL ESSAY PRIZE

Last year in response to a request from university students the date for submission of essays was extended to 20 January 1939 in order to include the university vacation at Christmas.

Eight essays were submitted, and on the recommendation of the examiners the prize on this occasion was awarded to Miss H. R. McClure, of Newnham College, for an essay on 'An historical and regional survey of the village of Styal, Cheshire.' This will be published in a forthcoming number of the *Journal*. The examiners were of opinion that the essays by Messrs. I. S. Maxwell and M. Macdonald Spencer are worthy of publication. Essays for the seventh award of the prize should be addressed to the Secretary of the Society by 20 January 1940.

## GEOGRAPHICAL DISTRIBUTION OF BRITISH SHIPPING

A large Mercator chart of the world showing as accurately as possible the positions of all British ships of and above 3000 tons gross on 24 November 1937 has recently been published by H.M. Stationery Office (price 3*s* 6*d* plus postage). The chart distinguishes vessels of over 10,000 tons, the number of vessels in the ports, and the percentage of important commodities drawn from the chief sources of supply. It thus displays impressively the important sea routes of the Empire, and the strategical framework upon which their maintenance depends. The importance of the Mediterranean and Red Sea routes needs no emphasis, but that of the traffic on the route to the West Indies and of the position of the Cape Verde Islands is perhaps not so generally recognized. It is of interest to compare this chart with the one previously issued for 1936. For that year the date chosen was March 7, so that apart from changes which might be attributable to political conditions, a comparison brings out the seasonal fluctuations in the geographical distribution.

The number of vessels shown was slightly larger at the later date: 2476 as against 2457 in 1936. An indication of the proportion this bears to the total British merchant marine and of the percentage of the imports carried in British ships would be useful. An obvious example of the seasonal difference is shown by the Baltic: seven vessels in port and none at sea in March, five in port and ten at sea in November. A more important one is afforded by the St. Lawrence and the Black Sea: no vessels were in the former in March 1936, while at the later date there were thirteen on the river and twenty-three in the ports; similarly for the Black Sea and Aegean, six vessels are plotted for March as against twenty-seven in November, of which fourteen were in the Black Sea and ten in ports. This Black Sea traffic probably also accounts for the larger number at sea in the Mediterranean at the later date, the numbers in the Red Sea being much the same in both cases. A decline in numbers is noticeable in Chinese waters, and the comparative desertion of the Pacific is striking. It might have been expected that the chart for November 1937 would have shown more vessels making their way south for the opening of the Antarctic whaling season. The charts are accompanied by tabular statements dealing with the principal commodities imported into Britain. These supplement the information on the charts, where the groups are composed and placed rather arbitrarily with regard to their sources, though this has been somewhat improved on the later chart. It may be noted that in these years the imports of coffee from British East Africa increased from 26 per cent. to 42 per cent.; that 28 per cent. of the

iron and scrap imported in 1937 came from French North Africa, 85 per cent. of manganese ore from India, and 81 per cent. of nickel from Canada. The Dutch West Indies and Venezuela provided 32 per cent. of petroleum and products, followed by Iran with 23 per cent.

These charts are worthy of careful study, and form a valuable adjunct to all geographical libraries. G. R. C.

## THE DISTRIBUTION OF FRENCH INDUSTRY

We have received from M. Jean Majorelle a copy of a paper on the industrial centres of France which he read at the Congrès de Géographie Aérienne, Paris, 1938. Analysing the official statistics, he brings out the characteristic of French industry: dissemination among small and medium factories, accompanied by the concentration of the industrial population in a small number of highly industrialized areas. In 1931, 7 per cent. only of the total number of factories employed more than 20 workers, and 1·5 per cent. more than 100. Thirty-five enterprises employed more than 5000 workers, and of these 19 were mines. One-quarter of the active population was engaged in industry, and of this 20 per cent. worked in factories employing more than 1000. It is also significant that two-thirds of the workers in enterprises employing more than 500 were engaged in mines, metallurgy, metals, and textiles. The tendency towards the evolution of large-scale units however has increased recently, for though the number of factories remained approximately stationary between 1921 and 1931, the number employing more than 500 workers increased by 36 per cent.

The writer then outlines the distribution of the industries, emphasizing the tendency to concentration in the north and north-east, near the more vulnerable frontiers. Twenty per cent. of the industrial population works in the Departments of the Seine and Seine-et-Oise. He discusses the causes of this concentration and localization. The fundamental cause being the search for the lowest cost price, he considers that large-scale production cannot be checked; localization however still leaves a certain scope for individual freedom, and its importance decreases with the decrease of the share of material in the final cost price. The factors in localization are raw material and communications, labour supply, consuming area, and special regional qualitative conditions, modified by past political factors, individual initiative, and chance. He urges the decentralization of French industry where possible, though recognizing the difficulties arising from the immobility of the industrial population, and cites the decision of the War Ministry to refuse contracts to factories established in the Paris region since 1934, and the transference of works to the south-west of Paris. He pleads for the thorough examination of the Central Massif and Pyrenean regions with a view to the partial redistribution of industry based upon water-power.

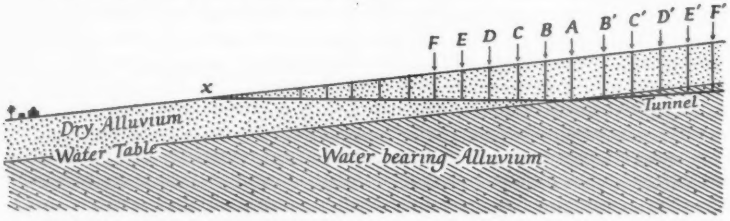
## WATER SUPPLIES IN 'IRAQ: THE *KEHARIZ*

In the review of Dr. W. A. Macfadyen's 'Water supplies in 'Iraq' ('Iraq Geological Department, No. 1, 1938) in the *Journal* for February 1939 (pp. 159–60), the essentially simple nature of the *kehariz* (the *qanat* of Iran) has not been appreciated by the reviewer. The following brief description of the principle underlying this form of water supply may help to clarify what appears to puzzle many travellers.

The *kehariz* or *qanat* is merely an ingenious method for drawing on underground water without having to lift it to the surface, and its construction does not necessarily require any precise surveying or levelling. The essential condition is an inclined terrain, usually alluvial, with an underlying water-table, as illustrated in the accompanying diagrammatic section.

If a *qanat*-maker digs a vertical shaft at a suitable place *A* he will strike the water-table at an elevation higher than the village or cultivation to which it is required to bring the water. From the experience of wells already in existence, and the slope of the ground, the choice of locality will not be difficult and can be made without any surveying: it is necessary to bring the water out *above* the place requiring supply, not exactly at the place, which would be a very different problem.

From the bottom of shaft *A* a level tunnel ("almost level") is excavated in the direction of the required exit, and at suitable short intervals vertical shafts, *B*, *C*, *D*, etc., are made to assist in the removal of material. To keep the tunnel level is a simple matter, for during the digging it will contain a few inches of water percolating from the water-table, which has been tapped at *A*. To drive an approximately straight tunnel for short distances between shafts does not require great accuracy. If necessary, for longer distances sufficient accuracy can be achieved by hanging two aligned pendulums down the shafts and keeping the bobs in line during the digging. Eventually the almost horizontal tunnel




emerges at the surface at *X*, the distance *AX* obviously depending on the slope of ground and the depth of the water-table. The trickle of water now flowing at *X* may be led off as required on the surface.

The next stage is to increase the flow to the required proportions by extending the tunnel in a similar way in the opposite direction (*B'*, *C'*, *D'*, etc.), cutting into the top of the water-table. As the tunnel is extended the percolating water will flow away to *X* and the work can be continued until a sufficient flow is obtained. If the rate of percolation from the sides of the tunnel is comparatively slow, as it usually is, the tunnel can be driven entirely in the water-table (levels permitting) without endangering the diggers.

The *qanat* may eventually give a reduced supply or dry up for two reasons, apart from blockage by roof falls and natural causes. A gradual fall in the water-table caused by the artificial drainage is sooner or later inevitable, and the remedy lies in deepening the tunnel or prolonging it to tap more of the water-bearing alluvium. On the other hand carbonate deposits form on the water-bearing surfaces, and their deposition may be surprisingly rapid in desert regions. The cure for this lies in scraping the walls. This feature of *qanata* is important to travellers in search of evidence of climatic changes, for as they do not provide a permanent water supply, they must not be compared to natural springs. They are a disturbance of nature's equilibrium, and their period of use is in consequence limited. Lines of abandoned dry *qanata* and deserted villages are not necessarily evidence of desiccation. N. L. F.

## HUMIDITY OVER THE GLOBE

In the *Annalen der Hydrographie und Maritimen Meteorologie* (Heft VIII, 1938) there is a useful paper by Dr. J. Száva-Kováts, of Budapest, entitled

"Verteilung der Luftfeuchtigkeit auf der Erde" accompanied by two coloured maps showing distribution of mean vapour pressure and relative humidity for January and July. The data, provided by about six thousand stations of necessity somewhat unevenly distributed over the globe, are based mainly on the decade 1920–29. Confidence is expressed that errors due to irregular distribution of the stations, comparative shortness of the period of observations, and to the fact that values for the oceans have been calculated instead of directly observed can only be small. The humidity over the sea has been derived from sea-surface temperature and salinity, air temperature, and wind velocity, and it is stated that the values so derived tally well with actual observations from island and coastal stations.

Vapour pressure (absolute humidity) rises and falls for the most part with temperature, the figures ranging from over 22·5 mm. in the Amazon basin and the Gold Coast, as well as in southern Asia in July, to below 1 mm. in the Arctic in January. Irregularities however are introduced by the deserts, where the values in both hemispheres are about 10 mm. in summer and 5 mm. in winter. Yet the average over the Sahara is not much smaller than over England, indicating that though the desert air is often extremely dry the high temperature sometimes allows considerable content of water vapour when moist winds blow inwards.

Relative humidity is much less closely related to temperature than vapour pressure, for though there is a similar equatorial belt of maximum dampness, exceeding 85 per cent., there are two equally damp belts in the cool temperate latitudes of both hemispheres. In January practically all Europe and Canada are as high as 85 per cent., and in July correspondingly damp areas appear over the north Atlantic and north Pacific oceans. The distribution brings out the importance of studying relative humidity in relation to vapour pressure. Thus the Canadian winter appears by relative humidity to be as damp as the English, but so small is the vapour pressure on account of the low temperature that winter in Canada is, as is well known, physiologically dry. The deserts both summer and winter show relative humidity about 50 per cent., but again it should be emphasized that this is an average figure covering great variations from one day to another, as records from places in the Sahara abundantly testify.

## INTERNATIONAL SOCIETY OF PHOTOGRAMMETRY

At the final session of the International Congress of Photogrammetry at Rome in October last, Professor Schermerhorn, of Delft, was elected President of the International Society of Photogrammetry, and B. Scherpbier, of The Hague, was appointed Secretary. It is proposed to hold a meeting for the discussion of photogrammetric subjects during the Congress of Geodesy and Geophysics at Washington in September next, and an exhibition of the work carried out in the various countries, but a definite decision has not yet been taken.

During the Rome Congress the first number of the journal *Photogrammetria* was issued. In addition to publishing articles on this subject, it will be the official organ of the International Society and of the national societies. It is published by Herbert Wichmann, Berlin-Grunewald, at four dollars a year, or three dollars through the national societies.

## OBITUARY

### PROFESSOR HENRY BALFOUR, F.R.S.

We record with deep regret that Professor Henry Balfour, F.R.S., Curator of the Pitt-Rivers Museum and President of the Society from 1936 to 1938, died at Oxford after a long illness on 9 February 1939. At the Afternoon Meeting on February 13, the day of his funeral, the Chairman spoke of his long service to the Society on Council, and of his courage in facing crippling ill-health during his Presidency. A memoir of his distinguished services to geography and anthropology will be published later.

## MEETINGS: SESSION 1938–39

Sixth Evening Meeting, 23 January 1939. The President in the Chair

*Elections:* Miss Frances Eleanor Barendt, B.A.; Lieut.-Colonel Alexander Elder Beattie, C.M.G., C.B.E., M.C.; Major A. A. Stuart Black; Mrs. Reynold Bray; H. Capriles; James Oscar Max Clark; Albert Edward Cooper; Gordon William Creighton; Mrs. Flora Grace Davies; James Stirling Gillespie; Basil P. Greenwood; Alfred John Healey; Thomas Temple Hoopes; Bt.-Colonel Laurence Hungerford Jackson; Miss Cecilia Anna Mary Jenkins; Elizabeth Lady Knott; The Reverend Sydney Ernest Longland, M.A.; Duncan V. McConnell; Harold Boston Millar; Richard Munday; Miss Winifred Clara New; Major Gordon Hutchinson Osmaston, M.C., R.E.; Captain the Hon. Anthony Phillimore; Brian Waldron Rose; Jai Singh Saini, B.SC.; Thomas Duncan Scott; Mrs. Joyce Seligman; Arthur John Spicer; Captain G. J. K. Stapleton; Peter Francis Thomas, B.A.; Mrs. Charlotte Mary Winsloe

*Paper:* Expedition to the Gilf Kebir and 'Uweinat. By Major R. A. Bagnold, O. H. Myers, R. F. Peel, and H. Winkler

Seventh Evening Meeting, 6 February 1939. Professor Kenneth Mason, Vice-President, in the Chair

*Elections:* Marc Allégret; William Joseph Butt; Miss May Sherwood Campbell; Wilfred Cooke, M.A.; Singha Deva Das, B.A.; Reverend George Fressanges; Paul Brewster Furlong; Miss Ursula M. Griffin; Richard Angelo Bennett-Levy; Cuthbert Maughan; Raymond M. Patterson; Reverend A. P. Quentin; Mrs. Sophia A. Saucerman; Miss Mabel Tunstall; N. J. D. Turner; Dr. Robert N. Webb; F. Carrington Weems

*Paper:* Exploration of ancient sites in northern Afghanistan. By Mr. Evert Barger

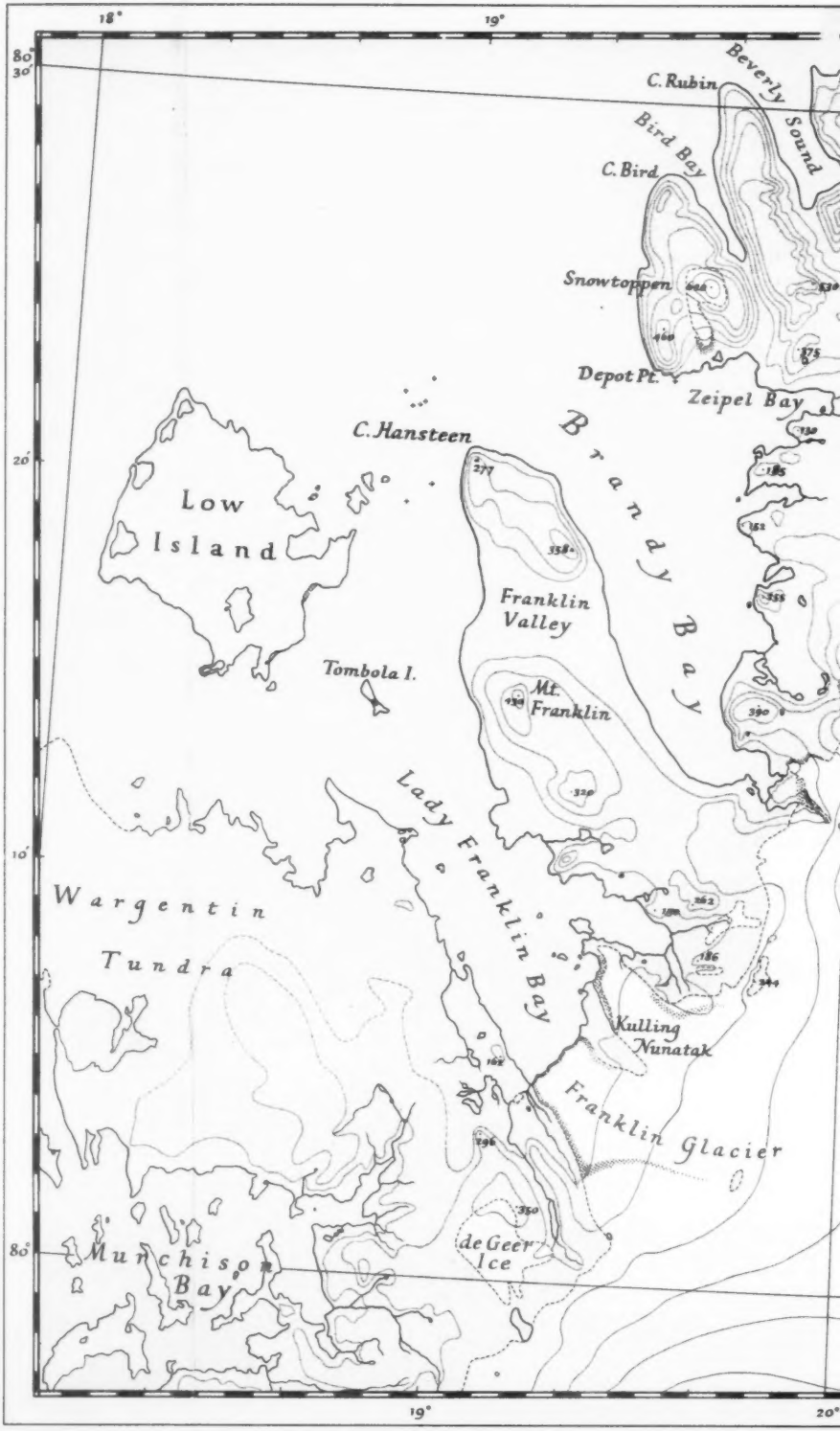
Fourth Afternoon Meeting, 13 February 1939. Mr. J. M. Wordie, Honorary Secretary, in the Chair

*Paper:* Modern coastal changes in east and south-east England. Discussion opened by Mr. J. A. Steers

Eighth Evening Meeting, 20 February 1939. Professor Kenneth Mason, Vice-President, in the Chair

*Elections:* Reverend Harry Basham; Mrs. Mabel Basham; David Alexander Brown, M.SC., F.G.S.; Allan Bryant Crawford; Mrs. L. H. Balfour-Davey; A. L. Duggan; Parimal Kumar Guha; Angus Boys Kinloch, A.M.I.M.T.; Mrs. Margaret Dorothy Law; Vishwa Nath Sahai Mathur, M.A.; Reginald Hugh Murray; Major-General Henry Needham, C.B., C.M.G., D.S.O.; M. Hanumant Rao, B.A.; George Scarborough; Michael Scott; Arthur Short; Miss Hilda Turnbull

*Paper:* The Masherbrum Expedition, 1938. By Professor T. Graham Brown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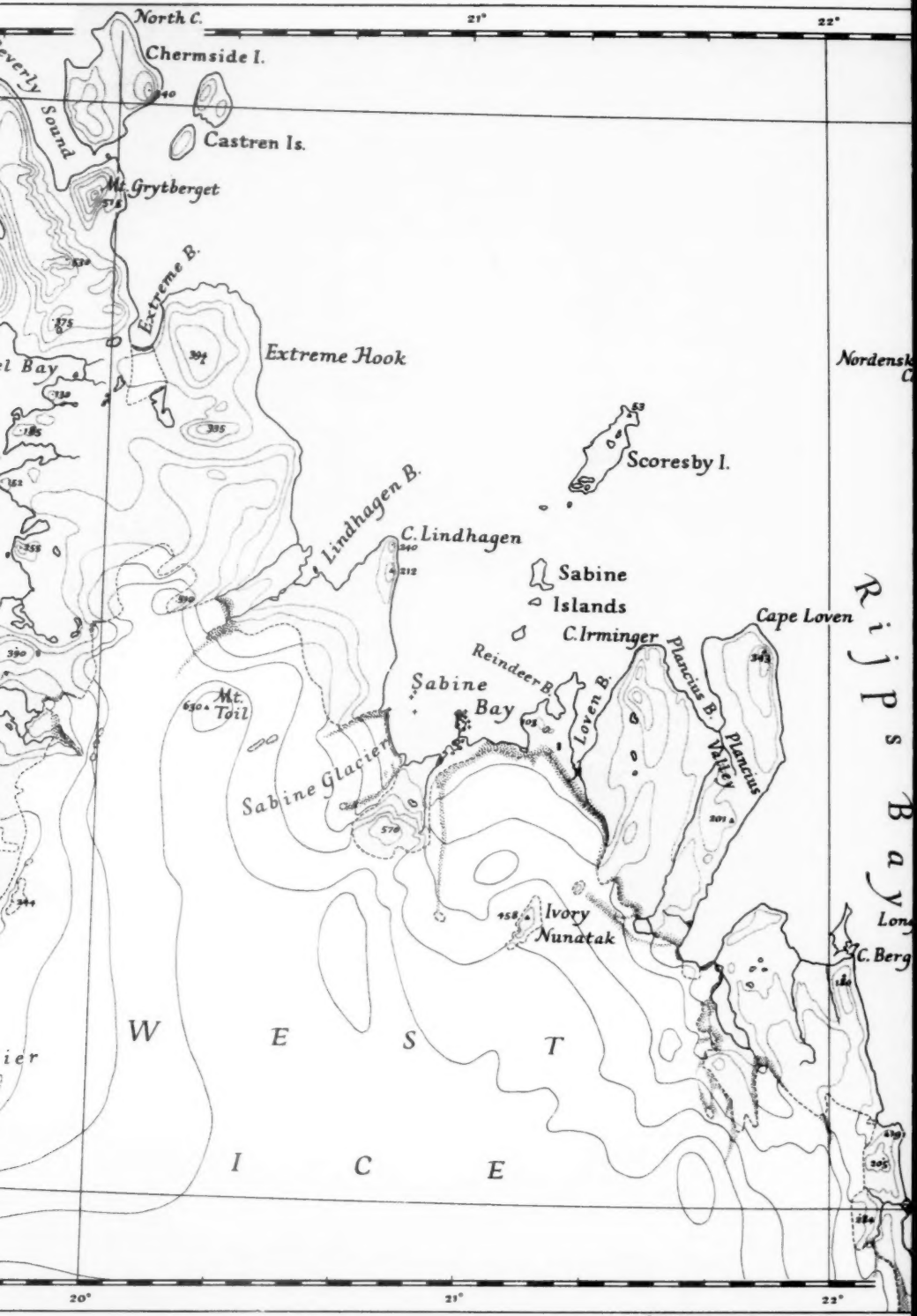
Zeipel Bay
C. Hansteen
Brandy Bay
Low Island
Franklin Valley
Tombola I.
Mt. Franklin
Lady Franklin Bay
Wargentin Tundra
Kulling Nunatak
Franklin Glacier
de Geer Ice
Murchison Bay

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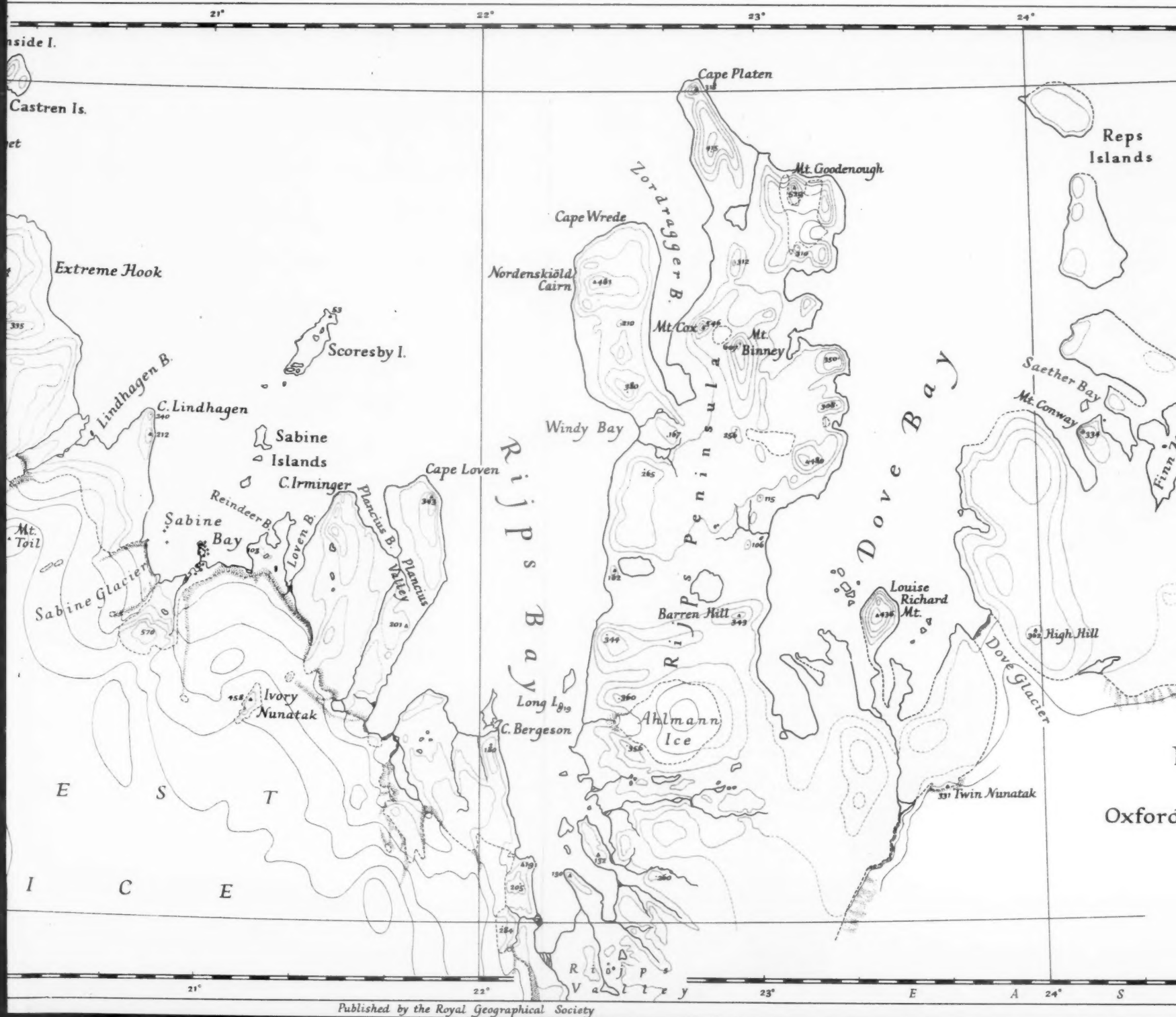


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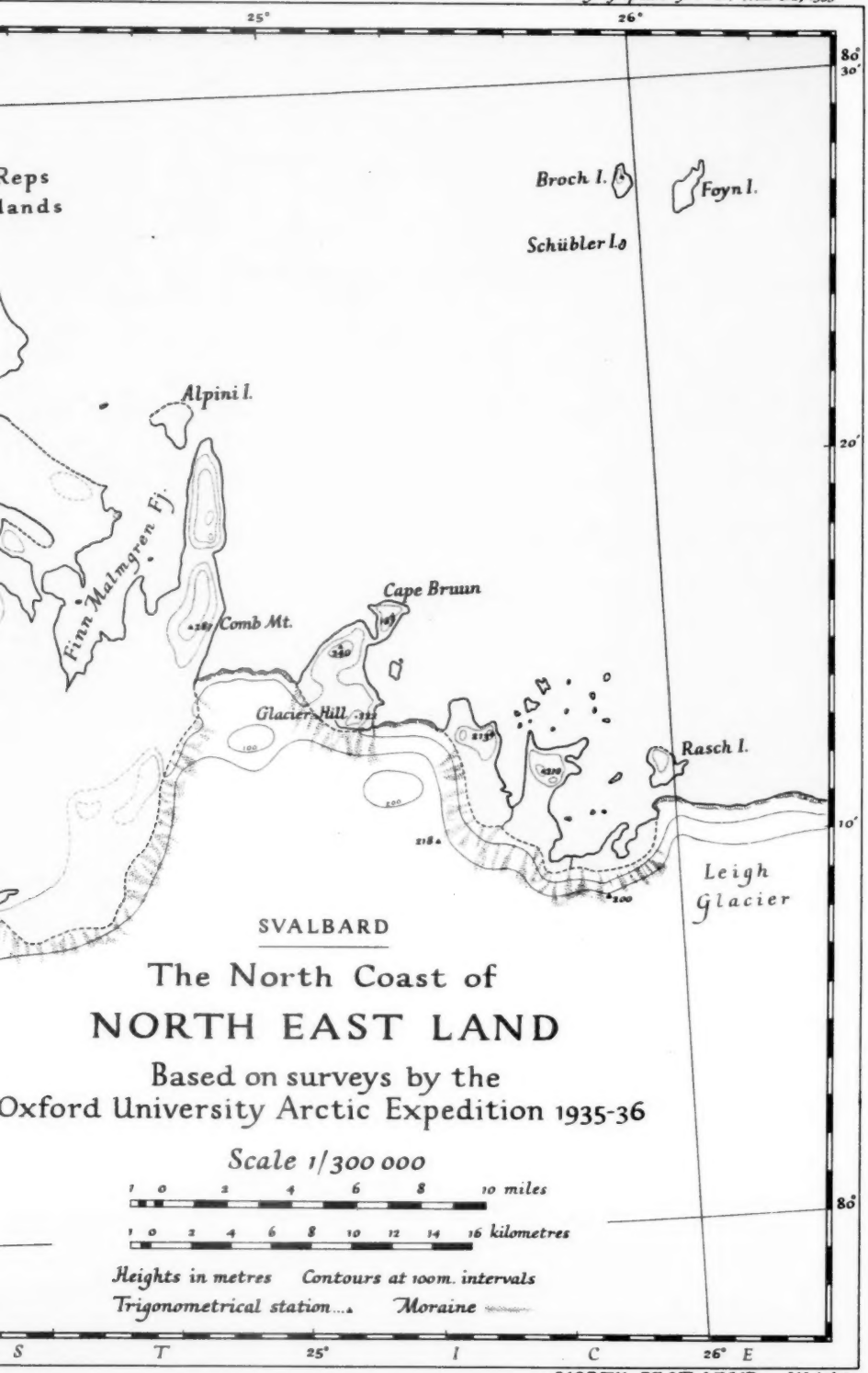
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Finn Malmgren Fj.
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Glacier Hill
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Leigh Glacier
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The North Coast of
NORTH EAST LAND
Based on surveys by the
Oxford University Arctic Expedition 1935-36
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Heights in metres Contours at 100m. intervals
Trigonometrical station Moraine
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